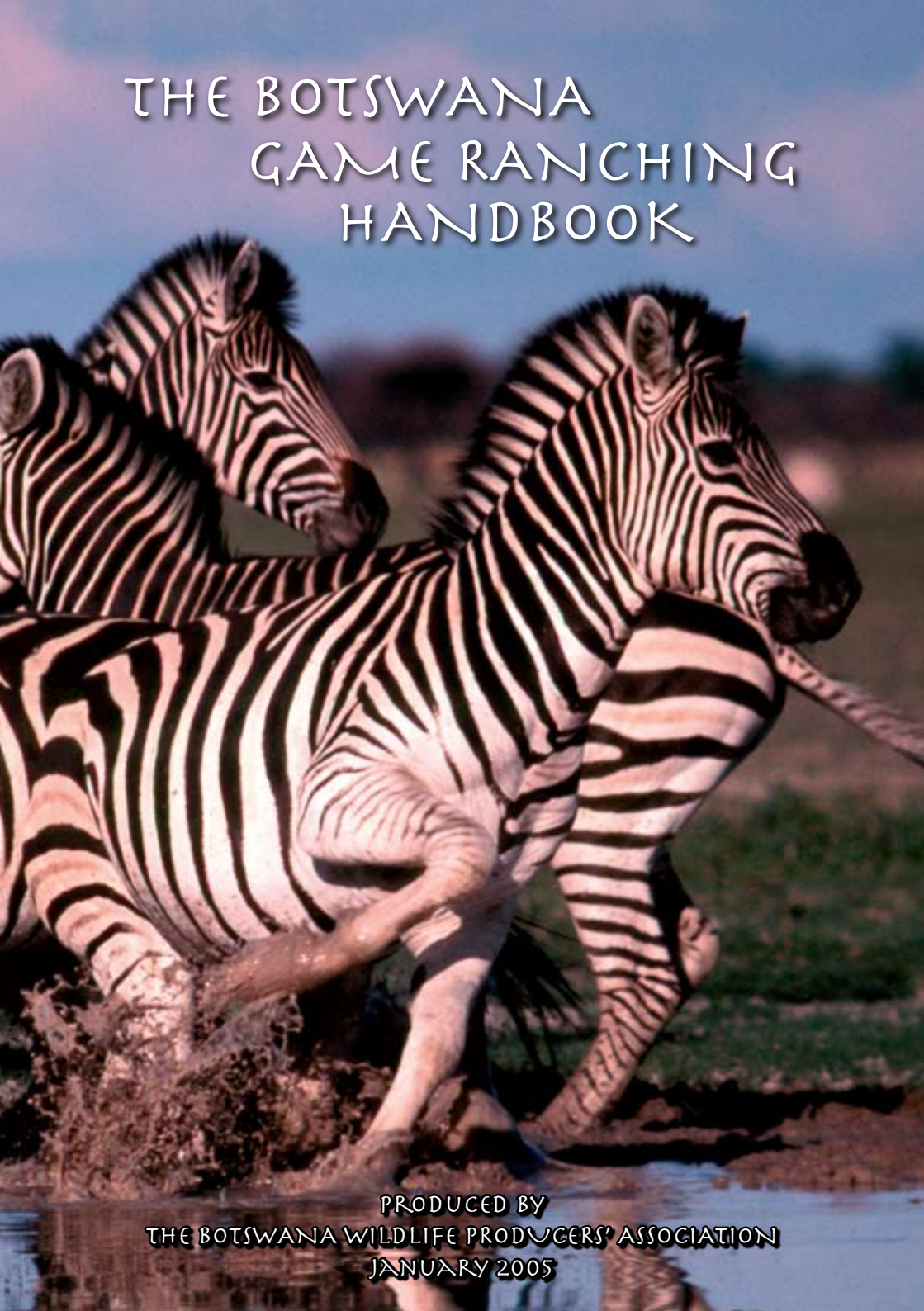
THE BOTSWANA GAME RANCHING HANDBOOK



PRODUCED BY
THE BOTSWANA WILDLIFE PRODUCERS' ASSOCIATION
JANUARY 2005

ACKNOWLEDGEMENTS

This handbook is intended as an introductory general guide to ranching with wildlife in Botswana. It is meant to be read mainly by farmers, especially those that are embarking on a new venture of which they have little or no experience. The varied environments and conditions to be found throughout a vast country such as Botswana demand a variety and range of advice and information that are far beyond the practical limitations of a small handbook, so, at best, it seeks to cover only the basic considerations for game ranching in this country.

For the sake of easy reading it has been written without including references in the text. This does not mean that all the contents are original – far from it; the bulk of the information is taken from one or two generally accepted reference works for southern Africa. *Game Ranch Management*, an encyclopaedic volume compiled from the works of a great many knowledgeable authors, by Professor J du P Bothma is the basis for much of the contents, which have been merely adapted where necessary for Botswana's unique situations. All aspiring and existing Botswana game ranchers will find it indispensable. Other major sources include *The Capture and Care Manual*, edited by Andrew A. McKenzie, and *Wildlife Ecology and Management*, a guide to game ranching produced for Zambia by Ulrike Zieger and Andrew Caldwell.

The production of this handbook would not have been possible without the assistance of the German Development Service (ded) who very kindly donated the required funding.

Our sincere thanks also go to Dr. Larry Patterson, who was commissioned to produce this handbook on behalf of the Botswana Wildlife Producers' Association.

D.H. Moore
Chairman

ded
Deutscher
Entwicklungsdienst

PREFACE

Botswana's economy has seen significant changes since Independence. The traditional sources of national and personal incomes and livelihoods, namely agricultural and in particular, livestock farming, have been replaced by other sectors in the economy. It has also become necessary for us to find alternative uses for some of our agricultural land, especially as our whole weather situation has made rainfed arable farming and livestock ranching very unreliable. Game ranching offers one such alternative land-use.

In the past, ranches were exclusively used for livestock farming. The changing economic circumstances have, however, been forcing livestock farmers to find more economic uses for their land as livestock farming alone was unable to pay for their investments. We therefore started witnessing an emerging trend whereby most livestock ranches were also used for game ranching as an add-on activity whilst cattle ranching remained the core enterprise on the ranch. However we are beginning to see more and more livestock ranches being turned into game ranches exclusively or ranches being established for game ranching. These developments are in part dictated by the socio-economic circumstances and the changing lifestyles of our time.

The management of game differs significantly from that of livestock. I therefore welcome the initiative by the Botswana Wildlife Producers' Association to develop a Game Ranching Handbook. The book is intended to inform those who are already in the industry and new entrants to the industry with information that will assist them to maximise the returns on their investments.

Whilst game may not be susceptible to as many diseases as livestock, and they require less care because of their better adaptability to the environment, the establishment of a game ranch is a very expensive undertaking. The cost of the construction of the infrastructure and its maintenance, especially the game proof fence, are very expensive. It is therefore necessary that those who venture into

the business are fully informed and continue to have good reference materials to guide their operations. It is my belief that this Handbook will serve that purpose.

In our national economic development policy pronouncement, we have repeatedly emphasised the need for economic diversification if we are to compete in the global market place. I am happy that the Botswana Wildlife Producers' Association has positively responded to this call and instead of seeing our ranches losing value due to depressed farming activities, came up with alternative uses for the vast tracts of land we have previously reserved for livestock farming. Game farming offers a viable alternative land-use especially as agricultural production has been adversely hit by recurring droughts. Most game species are either browsers and/or better utilisers of grazing resources. Some can live for months without water and are therefore able to survive weather conditions under which livestock would perish.

In terms of enterprise diversification, game ranching offers a better alternative than livestock farming. Ranchers can sell game for hunting, use their ranches for photographic safaris, game viewing, education and tourism. From a conservation perspective, game ranches form an important segment of the protected wildlife areas. In some countries endangered species can only be found on such ranches. They can also be used for captive breeding to restock the wild. Game ranching business is therefore an important activity that has the potential to support our national objective of sustainable use of our wildlife resources. I applaud the Botswana Wildlife Producers' Association for continuing to promote game ranching in Botswana and coming up with this Handbook to further empower Batswana with knowledge to succeed in their game ranching operations.

The Honourable Kitso Mokaila
Minister of Environment, Wildlife and Tourism

January 2005

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1 INTRODUCTION

1.1 Botswana's natural environment

Much has been written about Botswana's natural environment. Its basic geology, climate, landscapes, soils, hydrology, vegetation and wildlife have all been well documented. A great deal has also been written about demography, landuse practices and recent infrastructural developments. This introduction merely describes the country in simplified general terms in order to give a brief overview of the present-day situation.

Located in central southern Africa, bisected by the Tropic of Capricorn, Botswana is a largely flat country occupying a plateau some 1000m above sea level. Its lowest point is in the Limpopo valley along the eastern border and, apart from a few isolated groups of small hills and koppies, areas of slightly higher ground are restricted to the Schwelle (west of Kang), the Ghanzi ridge and the southeast, centred on Kanye. It can be divided into two main zones according to soil type: the eastern hardveld, which supports the vast majority of the people and therefore developments, and the Kalahari sandveld of the central and western areas which occupies approximately 75% of the country and is sparsely inhabited and relatively undeveloped. (Fig1.1).

The climate is fairly extreme and semi-arid. Mean annual rainfall varies from approximately 200mm in Bokspits in the southwest to almost 700mm in Kasane in the far north (Fig1.2). However, rainfall is very erratic, with large differences between years and unpredictable distribution in any given year. Reports over the last century or so suggest that the country is becoming drier over the long term, with more of the rainfall consisting of short, heavy storms resulting in increased run-off and less beneficial soaking. Rain falls almost exclusively in the summer months

between October and March, when daytime temperatures may exceed 40^0C. In the dry winter night frosts occur frequently, especially in the south and west. Evaporation far exceeds precipitation.

Water is scarce. Permanent surface water is largely restricted to the north in the Chobe and Okavango river systems. Rivers in the east are seasonal at best and more usually just ephemeral. Pans rarely hold rainwater beyond the middle of the dry season. In the sandveld, there are no rivers and pans are limited in number, leaving large areas completely devoid of surface water all year round.

Game ranching will depend on the availability of groundwater almost everywhere in Botswana. A professional survey should be undertaken before any large-scale expenses are incurred for developments. Ground water resources are fairly widespread, though they may be very deep in the Kalahari and expensive to exploit. In some areas, e.g. Makalamabedi, the ground water resources are extremely saline and may not be suitable for some species.

The vegetation is dependent on soils and rainfall, and although there is considerable local variation it can conveniently be divided into three main types:

- a mixed wooded savannah, dominated by *Acacia* and *Combretum* species on the eastern hardveld, extending north to around Palapye;
- a mopane-dominated woodland and shrub zone in the north and east, also mainly on hardveld;
- bush and shrub savannah on the Kalahari sandveld.

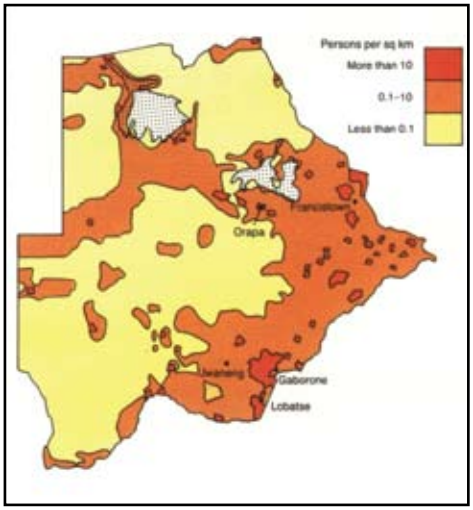


Fig 1.1 Population Density

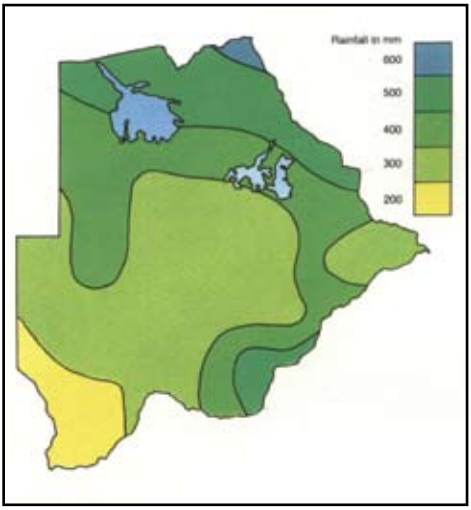


Fig 1.2 Mean Annual Rainfall

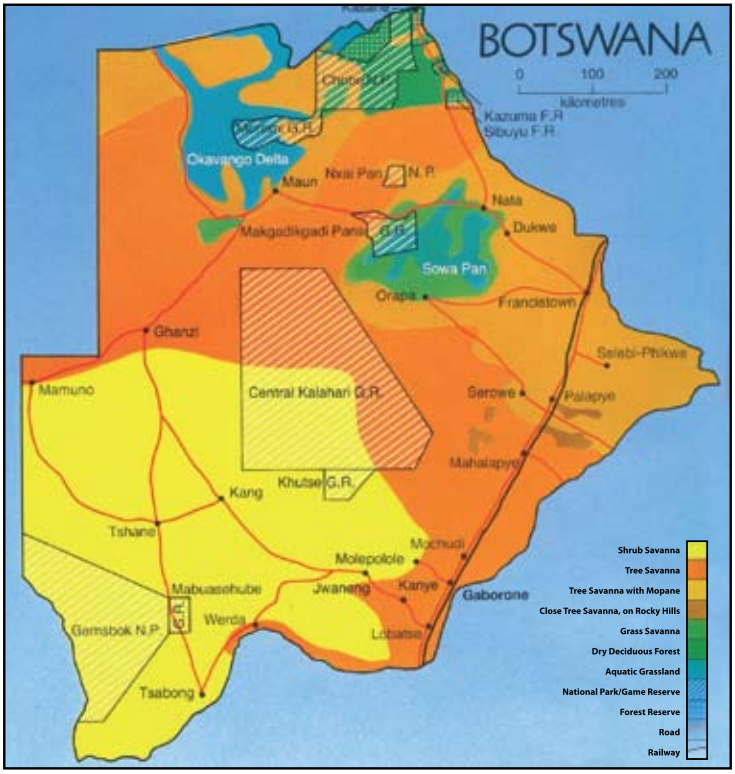


Fig 1.3 Designated Wildlife Areas

Species	Kalahari sandveld	Eastern hardveld	Northern ranges
Buffalo			++
Bushbuck		++	++
Duiker	++	++	++
Eland	++	+	++
Elephant		+	+++
Gemsbok	++		
Giraffe	+	+	++
Impala		+++	++
Kudu	++	+++	++
Red hartebeest	++		
Reedbuck		+	++
Roan antelope			+
Sable antelope			+
Springbok	++		
Steenbok	++	++	++
Tsessebe		+	++
Warthog	+	++	++
Waterbuck		++	+
Blue wildebeest	++	+++	++
Zebra		+	++

Table 1.1 Wildlife ranges in Botswana

Wildlife still occurs throughout the country, except in urban areas. Populations of large ungulates such as wildebeest and hartebeest suffered badly during the severe drought of the 1980s and their numbers fell by up to 90% in the Kalahari. They have never really recovered from this and human expansion with new developments and infrastructure now form insurmountable obstacles to the repopulation of their natural ranges. In contrast, over the same period the elephant population in the north has more than doubled and extended its range accordingly. In the more heavily populated east most large wildlife species have given way to human development, but kudu and pockets of others, such as impala and warthog still survive. Good numbers of many species have always been maintained in the fenced freehold farms of Tuli Block and these have formed an expanding nucleus of stock for the recent development of game ranches. Table 1.1 indicates the natural ranges of most of the large wildlife species within the country. Some of these have been skewed by human interference, but it serves to show where most of the species should thrive.

1.2 Landuse and wildlife conservation in Botswana

A large proportion of land is still available to wildlife in Botswana. Approximately 17% of the country comprises national parks and game reserves (commonly called protected areas [PAs]) and a significant further amount is designated as wildlife management areas (WMAs). It is often quoted that the total proportion of land therefore "dedicated" to wildlife conservation is around 40% (Fig 1.3).

There is no practical difference between national parks and game reserves. Both are fully protected by law and managed by the Department of Wildlife and National Parks (DWNP), but national parks are situated on state land and game reserves are on tribal land. WMAs have existed in various stages of planning and development since the late 1970s, but final gazettement and meaningful status has varied in

different parts of the country. Functioning management of WMAs only really occurs where they are leased as concession areas by the private sector e.g. in the Okavango Delta.

The whole of Botswana, with the exception of urban areas, is divided by DWNP into controlled hunting areas (CHAs) for administrative purposes. This status does not reflect the presence or absence of wildlife and, in fact, the majority of CHAs outside WMAs do not have a hunting quota other than for small game.

Outside WMAs, in several of the communal farming areas, there is a growing trend; turning away from traditional cattle rearing and investing in wildlife. Fencing in these areas was initiated by Government with the advent of the Tribal Grazing Lands Policy (TGLP) in the 1970s. Although wildlife was initially excluded from the newly fenced areas, recent developments, sometimes with government assistance (FAP and CEDA), have been towards developing game ranches. The Hainaveld ranches in Ngamiland are the best example of this trend. The Agricultural Policy of 1990 allows fencing of traditional grazing areas around boreholes in all communal areas, but the local authorities in the form of the District Land Boards have sometimes been reluctant to allow the implementation of this policy.

1.3 Development of game ranching in the region

This section contains a condensation of a great deal of information about the game ranching industry, its development and current status in the region, and its prospects in Botswana. In order to make it readable the facts and figures have been smoothed, but not doctored, and the dozens of data sources, from government files, NGOs, private sector reports and personal communications are not acknowledged in the text. Substantial information is available from two neighbouring countries, Namibia and South Africa; both of these have well-developed and long-

standing game ranching industries. Zimbabwe has had a very successful game ranching and production industry, but it is presently in disarray with a dearth of up-to-date statistics. Other neighbours have fledgling industries and have contributed relatively little information, but similar developments have taken place e.g. Zambia.

1.3.1 Resources – land and wildlife

Botswana has approximately 1million large wild animals of 32 species. These animals mainly inhabit about 40% (230,000km^2) of Botswana – comprising protected areas, WMAs, and private land. Game ranches presently amount to just over 1% of wildlife land (less than Moremi GR). Game ranching began in the 1980s and there were still only 17 registered operators in 1999. There are now over 60 active game ranchers, although some have not yet completed their registration with DWNP. Total numbers of wildlife on game ranches are unknown, but an educated guess would be approximately 50,000 animals (±5% of the national wildlife herd).

Namibia also has 32 main species totalling approximately 750,000 animals. Most of these are the same as Botswana, though there are a few differences e.g. Hartmann's zebra. There are 400 commercial game ranchers owning approximately 25% of wildlife land. Remarkably these farms contain over 70% of the national wildlife herd (over half a million animals). In the last 20 years there has been an increase of 80% in animal numbers and 50% in species variety on private land. The creation of conservancies by combining adjoining game ranches is a notable trend.

In South Africa game ranching may be said to be "fully developed" as an industry. There are almost 10,000 game ranches comprising over 18 million hectares (though many are too small to be viable under Botswana and Namibian conditions and many are mixed wildlife and cattle enterprises). This is almost 75 times as big as in Botswana and can be

compared with the mere 7 million hectares of parks and reserves. It is estimated that private ranches contain 2½ times the amount of game that occurs in protected areas. It is often claimed that there is now much more game, spread over more land, than there was at the end of the 19th century after the depredations of white settlers and *rinderpest*.

	Existing game ranches	Combined area (km^2)	Proportion of wildlife estate (%)	Proportion of wildlife (%)
Botswana	60	2,750	1	5
Namibia	400	17,000	25	71
South Africa	10,000	180,000	72	71

Table 1.2 Regional comparisons of available land and wildlife resources

1.3.2 Utilisation of wildlife

Commercial game ranches rely on one or more of four basic sources of income: safari hunting for non-residents, "biltong" or recreational hunting for residents, live game sales and ecotourism. Combining these is not always easy, but an excellent example of an enterprise that combines at least three very successfully is Pilanesberg National Park - admittedly not a game ranch, but the principles still apply. The following analysis briefly compares the consumptive uses of wildlife in our region.
A simple breakdown is included in Table 1.3.

Botswana's legal harvest through hunting amounts to less than 4,000 animals per year. There are insignificant live exports at this stage, so the total offtake is in the region of 0.5% of the population. The majority of this occurs in the WMAs in either concession or community-leased areas. Non-resident safari (trophy) hunters amount to about 200 per year of which 75% are from the USA. The hunting opportunities for residents

and citizens in non-leased areas have reduced dramatically in recent years. No figures are available yet for the offtake from game ranches, it is small but known to be increasing.

In Namibia the total annual offtake is around 100,000 animals, made up of 10,000 live exports, 10,000 trophy animals and 80,000 hunted for meat/biltong or recreation. This proportion amounts to 13% of the wildlife population. Foreign trophy hunters exceed 2,000 per year of which 80% are European (70% German or Austrian) and only 6% from the USA.

In South Africa there are no available figures for the total offtake, but trophy hunting alone accounts for 25,000 animals annually. There are approximately 4,000 foreign trophy hunters of which 55% are American and 32% from Europe.

	Wildlife population	Total offtake (%)	Total value of offtake (Pmillion)	Trophy hunting (%)	Biltong/ Recreational hunting (%)	Jobs (directly employed)
Botswana	1,000,000	0.5	100	90	<10	1,000
Namibia	750,000	13	276	63	31	2,500
South Africa	2,500,000	12 (?)	750	22	58	50,000

Table 1.3 Comparison of returns from consumptive utilisation

1.3.3 Key species

In Botswana the hunting industry is heavily skewed towards very expensive, traditional "big game" safaris in large exclusive areas. The main attractions are charismatic species such as lion, leopard, elephant and buffalo. Safari companies rely heavily on these species to attract clients and sell less glamorous species in a "package". Recent quotas indicate a decline in availability of some of these key species, either for ecological

or political reasons. This trend, if it continues, will dramatically curtail this industry, leading to a swift fall in the value quoted in Table 1.3., but would create further opportunities for game ranch development.

In Namibia the most popular trophies hunted are gemsbok, kudu, warthog, springbok and hartebeest, which account for over 70% of trophies. Note that these species also rank highly as meat/biltong animals too and at least 5 times as many are utilised this way.

In South Africa the statistics are vast and complex, with almost 100 species being taken as trophies (including birds and reptiles), but 16 species account for 75% of trophy fees. The most popular trophies are impala, springbok, blesbok, warthog, kudu, gemsbok and blue wildebeest, amounting to 60%. Charismatic species are also a draw card here too, but the manipulation of trophy fees means, for example, that both impala (3500 trophies) and white rhino (45 trophies) each earn over P7 million annually.

1.3.4 Conservation successes

Game ranching has played a significant role in the conservation and increase in populations of several species in southern Africa. These include previously critically endangered species such as the Cape mountain zebra and bontebok in South Africa and the red hartebeest and black-faced impala in Namibia. These and others have been actively conserved on game ranches for many years. Utilisation has included controlled hunting and live sales, to the extent that during the 1980s Namibian ranches, for example, exported over 15,000 red hartebeest to South Africa, securing the species in its native range. Game ranchers have also played a significant role in providing safe range for both black and white rhinos over the years and are now instrumental in the dispersal of elephants, with 20% of the South African population on private ranches. In Botswana it is estimated that at least 6,000 animals have already been

translocated to game ranches. This has effectively distributed breeding herds of several species and contributed significantly to wildlife conservation. One example is that game ranches in Ghanzi now contain over 1,000 zebra, several decades after the species had disappeared from the Kalahari ecosystem. Another is the successful re-introduction of white rhino to one private ranch.

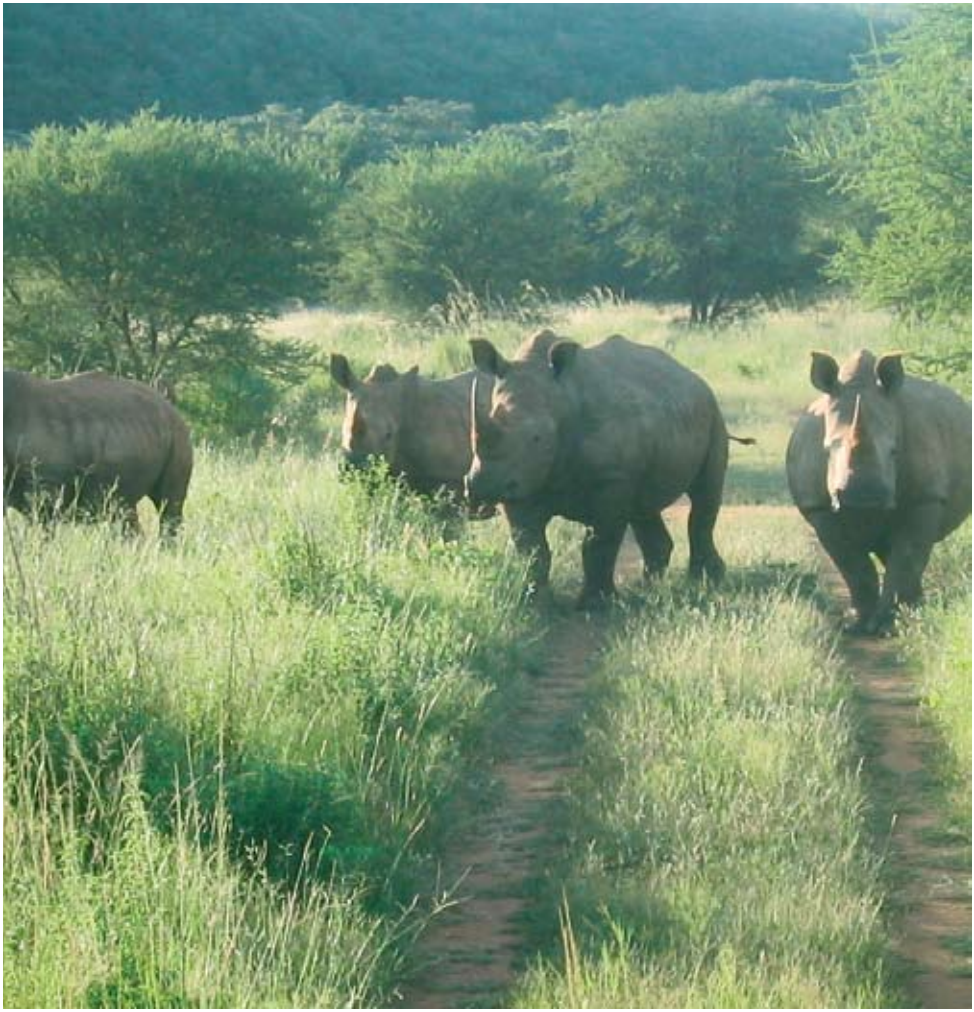


Fig 1.3 White rhino on game ranch

Capture boma - aerial view

Blue wildebeest in capture boma

2 PLANNING A GAME RANCH

2.1 Management options

Game ranching enterprises originally developed out of a desire by landowners to have a wildlife retreat for their own enjoyment. Economic considerations were limited to what the owners, invariably rich people, wanted to spend and very little thought was given to income generation. In more recent times wildlife production on private land has developed into an industry, taking its place alongside agricultural activities as a form of primary production, albeit with a strong conservation component. A major consequence of this shift is that game ranching needs to be economically viable. Income must be derived from its products. This leads to a number of options for ranchers to consider and demands a careful choice of objectives for the enterprise.

Potential sources of income

There are four generally accepted options for income generation from a game ranch:

- Hunting
- Ecotourism
- Live animal sales
- Meat production

These are not mutually exclusive; in fact, the vast majority of game ranches are compelled to employ a combination of ways to make money. The optimum levels of each activity depend on many factors: environmental, economic, seasonal and the stage of development of both the individual ranch and/or the national industry The chosen objectives have an important bearing on how the ranch should be developed from the outset, not least in the management of the natural resources and the provision of infrastructure. For example, maximum meat production requires different management inputs from trophy production, and

ecotourism activities need different facilities from meat production or live sales.

2.1.1 Hunting

This is normally divided into two categories - trophy hunting and so-called biltong hunting. These terms are not ideal and the two forms of hunting are not mutually exclusive. If we separate the activities in a way more appropriate to Botswana, we might better describe them as safari hunting and recreational hunting, with the former implying a high-cost, guided hunt for non-residents and the latter a less expensive option for residents/citizens.

Safari hunting

This is a specialised form of game utilisation, involving the hunting of exceptional trophy animals and is practised by the hunting client as a sport. The client attaches sentimental value to the trophy and is therefore prepared to pay a high fee for it. The hunting client is guided by a professional hunter. Animal numbers on the ranch must be limited to the level at which competition for resources between individuals is minimised and each animal is capable of reaching its genetic potential in terms of growth and trophy production. Heavily stocked ranches will not yield top quality trophies. The ranch should therefore be stocked well below the ecological capacity of the vegetation. Sex ratios must be maintained to produce the maximum number of males of trophy-bearing age.

Recreational hunting

This is aimed at satisfying the demands of local resident and citizen hunters wanting to shoot an animal at minimal cost for home consumption. The most important criteria for local hunters are the quality and price of the meat. Trophy quality is less important. The optimum selection of game for a ranch aiming at the local hunting market will closely

resemble the selection of game for venison production. The ideal species for this purpose would be animals adapted to the local conditions, with high reproductive rates and a good quality of venison, e.g. eland. Management can be simplified by stocking a limited spectrum of game. Sex ratios of the breeding stock should be maintained at the optimum level in favour of the females to ensure maximum production and reproductive success.

2.1.2 Ecotourism

This is a non-consumptive activity, where economic benefit is derived from wildlife without killing or selling it. Income is derived from guests who have the privilege of viewing or otherwise experiencing wildlife and the natural environment on the ranch. The keyword here is biodiversity, in terms of both habitats and wildlife species. A mosaic of habitats should be maintained through appropriate management of all the natural resources. Animal populations should be as high and varied as possible, but limited to indigenous species. Any offtake must be carefully managed to minimise disturbance and keep the animals as tame as possible for game viewing. If possible, charismatic species such as rhino should be included.

2.1.3 Live animal sales

The sale of live animals is currently an important cornerstone of the game ranching industry. While numbers of game ranches continue to increase this will remain the case because of the demand for stocking new ranches. At present in Botswana only very few ranches have sufficient stocks to be suppliers and there is a good demand. Ultimately though, supply must equal and then outstrip demand causing a fall in prices for common species. The future will then be in supplying smaller ranches that consume more than they can produce (as is already the case in some parts of South Africa), and in producing stocks of rarer species such as roan and sable antelope.

2.1.4 Meat production

In its simplest form this is akin to beef ranching, where animal populations are managed for maximum productivity of venison and by-products. In practice it rarely, if ever, occurs in isolation, but is always accompanied by other forms of utilisation. Wildlife cannot normally compete with domestic animals for meat production, but requires additional advantages, such as a specialised export market or marginal conditions e.g. lack of water resources. However, venison production is an important aspect of most game ranches.

2.2 Compatibility of options

It is rare that a game ranch will be managed for only one of the above options, since most will eventually produce an excess of one or other types of animals e.g. females or non-trophy males which will need to be utilised. To achieve maximum returns and profitability a game ranch today will usually be managed for a combination of safari hunting and live animal sales, with limited venison production. This, however, may change with time.

2.2.1 Ecotourism with consumptive options

Tourism and the consumptive uses of game are often considered incompatible options for various reasons. Many tourists feel repulsed when knowing that the animals they view today may be shot by hunters the next. The most attractive animals for viewing are the mature males with magnificent horns, but these will be fewer if regular trophy hunting takes place. Also, hunting may make animals shy and difficult to observe. Tourist activities are disrupted on days when hunting or capture operations take place. Direct conflict and potentially dangerous situations can arise when tourists and hunters frequent the ranch at the same time.
On the other hand, on a fenced game ranch with limited resources and where predation is all but absent, removal of surplus animals is essential.

This can be done as a concentrated culling exercise once or twice a year when tourist facilities are closed briefly. However, it requires a professional culling team and good facilities. This is a profitable option if the venison market is good, and it should lead to minimal disruption of the tourist operation. An alternative harvesting programme would combine tourism with trophy hunting, live sales and venison production. In doing so, it will have to be accepted that each of these options will be compromised to a certain degree by the others, and that strict management will be required. On a sufficiently large game ranch, spatial zoning provides the best solution. Here activities are restricted to their respective zones with free animal movement between them. On a small game ranch, the same can only be accomplished through temporal zoning by giving the exclusive use of the entire game ranch to tourists, hunters or game capture teams respectively, at a given time.

Another conflict arises when choosing an optimum stocking rate. For safari hunting and live sales of game, a ranch is stocked below the ecological capacity to ensure that animals are not limited by natural resources. For tourism, a high stocking rate is often advocated that will facilitate game viewing. However, it is often overlooked that this system constantly pushes an area's potential to support animals to its limit without leaving a safety margin for poor years. The ecological capacity will invariably be overstepped at some time, leading to deterioration of the vegetation as well as high mortalities among the game. Remember it is more pleasing to watch fewer animals that are in excellent condition than many animals in poor condition. Therefore, it is advisable to stock a game ranch that is used also for tourism purposes conservatively. This is especially true if tourism is combined with consumptive uses of game.

2.2.2 Cattle ranching versus wildlife

It has often been claimed that wildlife may generate greater financial benefits than domestic livestock. In terms of overall meat production

per hectare, wildlife cannot compete with beef cattle except in very dry regions. Cattle have for hundreds of years been bred for optimum energy conversion and effective growth. For an economic evaluation of a livestock versus a wildlife or mixed enterprise, every ranch must be considered individually in the context of the prevailing habitat conditions, market conditions, and the political and financial climate. A general feeling is that wildlife ranching is ecologically sounder and financially superior to cattle production if trophy hunting, live sales and game viewing tourism are integrated and where the political environment is conducive to marketing these assets. This is what Botswana should be aiming at.

The success of a game ranching enterprise depends on the efficiency with which it is marketed. The location of a ranch, its size, the number and variety of game, quality of trophies on offer, and the comfort of the facilities have an important impact on its attractiveness to both hunters and tourists alike. The demands for live game and trophies, and thus the prices obtained, are unpredictable. Such aspects do not concern the cattle rancher, as the marketing of cattle is standard procedure and the demand for beef and weaners, although fluctuating, is more predictable. The pricing structure for commercial beef cattle is generally such that the live value is closely correlated to the current meat value.

Cattle production, on the other hand, is associated with many expenses not relevant to game, e.g. veterinary expenses and extra handling facilities, even though the beef industry in Botswana also receives considerable financial assistance from government in the form of subsidies and free services. The managerial input with cattle is very high. The intensive management input on a cattle ranch, however, gives cattle several advantages over game. Individuals in a cattle herd that are not performing well are easily identified and removed. Sick animals can be identified and treated and cattle numbers can quickly and easily be adjusted to climatic fluctuations, such as droughts.

Cattle can be managed through a rotational grazing system, and in this way a large proportion of the available grass can be utilised as the cattle are forced to be unselective. Game is usually managed in a continuous grazing system, resulting in a less efficient utilisation of the vegetation. Browse is utilised by a variety of game, but production from browsers is small in comparison with that from grazers. However, the danger of over-utilisation and deterioration of the vegetation is greater with cattle ranching than with game, as evidenced by the severe encroachment of undesirable bush species on many farms in the Tuli Block and Ghanzi.

Expenses related to fencing and roads can be similar for cattle and for game. The increased internal fencing required for cattle could be equivalent to the increased perimeter fencing required for game. However, the fencing costs with game decline per unit area as the area increases, while this is not so with cattle.

Mixed ranching can be a sound alternative financially and ecologically. Many ranches in South Africa combine game and cattle in an effort to be more profitable. Mostly those game species should be selected that have little dietary overlap with cattle. However, some degree of competition is unavoidable, as browsers, just like cattle, will first utilise the succulent fresh leaves of forbs before resorting to browse and grasses respectively. Although the production on mixed ranches is diversified, and economically less risky than offering fewer products, such mixed ranches tend to be less attractive to game viewing tourists and hunters.

Game ranching requires that the habitat be managed for a diversity of species. Most wildlife is more specific in its habitat requirements than cattle, and there is thus an incentive to conserve a wide variety of vegetation types. Generally therefore, game ranches are environmentally sounder than cattle farms and can contribute substantially to a country's conservation efforts.

2.3 Basic considerations

The basic requirement for game ranching is obviously an adequate quantity of suitable land. Location is very important and the land should be in an area that has been designated by the authorities for this type of landuse. The size and shape of the parcel of land, and access to it are also important. The ecological classification, availability of water, variety of habitat types and neighbouring landuses also have a significant bearing on the chances of success.

2.3.1 Location and access

Land in Botswana is divided into three basic categories: tribal land, state land, and freehold land. The first two categories allow only for leasehold tenure, whereas in freehold areas, e.g. Tuli Block, ownership is outright. On freehold farms, the landowner has the right to use his land for game ranching as long as the authorities are informed. In leasehold areas, game ranching status must be applied for, through either the local land board or the Ministry of Lands and Housing (MLH).

Ease of access is important for practical and economic reasons. It may be very hard to reach some areas because of the deep sand roads. This makes deliveries of animals and other commodities more costly. It may be difficult to obtain labour in very remote areas; on the other hand, a peri-urban location, while convenient, may lead to poaching and vandalism.

Many other constraints differ with location, e.g. buffalo and other valuable species may not be moved to certain areas because of current veterinary regulations; other regulations may differ between WMAs and elsewhere. Natural or ecological constraints affect many aspects, e.g. springbok will not normally survive to the east of the railway line because of the prevalence of heartwater ticks; zebra may develop overgrown and deformed hooves if kept on deep sandveld.

2.3.2 Size and shape of ranch

The ideal size of a game ranch varies mainly with ecological classification and the intended purpose of the ranch. For example, ranches generally need to be bigger in more arid areas than in highly productive zones, and more land is normally needed to hold viable numbers of larger, wide-ranging animal species. As a rule of thumb for Botswana, it can be recommended that the minimum size in most areas should be approximately 4,000ha, although smaller ranches can be viable for certain purposes. It should always be remembered that the smaller the property is, the more intensive the level of management that is required. Taken to extremes – almost any species can be kept successfully in the small confines of a zoo, but then very high levels of specialised management are required. On large, exensive ranches the required management inputs per animal are much less.

The shape of the ranch influences many things, both ecologically and economically. The best shape approximates a square. Considering only the perimeter fence: a 6,000ha ranch that is almost square requires approximately 30km of fence, one that is 15 x 4km requires 38km of fence i.e. 25% more cost.

2.3.3 Ecological considerations

The lack of any significant geology or varied topography over the greater part of the country means that soils and climate (overwhelmingly rainfall) are the main ecological influences. Well-drained sandy soils predominate in the west and centre of the country, with more clays and harder soils in the east and north. Rainfall increases from the southwest to the northeast, with an annual average of 250mm in Bokspits and almost 700mm in Kasane. This essentially means that there is more and varied primary productivity (plant growth) and more surface water in the north and east. It follows that to be viable, game ranches in the western and central sandveld areas need to be larger than in the east.

2.3.4 Acquisition of land for game ranching

The process of acquiring land for purposes of game ranching varies with the type of land category.

- *Tribal Land:* Those interested in game ranching on Tribal Land have to obtain permission from the district land board. Before the land board will consider either a new application, or a request to change landuse to game ranching, they require approval from DWNP. Once DWNP approval has been received, the land board will consider the application. Normally leases are for fifty years at a current (2000) rental of P0.70 per hectare. This price is to be reviewed every five years
- *State Land:* On state land application is made to the Department of Lands, Ministry of Lands and Housing.
- *Freehold land:* On freehold land no permission is required from the district authorities.

In the case of Freehold and State Land however, at the time of writing the DWNP still require a management plan to be submitted and approved before the game ranch can be registered and issued with an approval certificate.

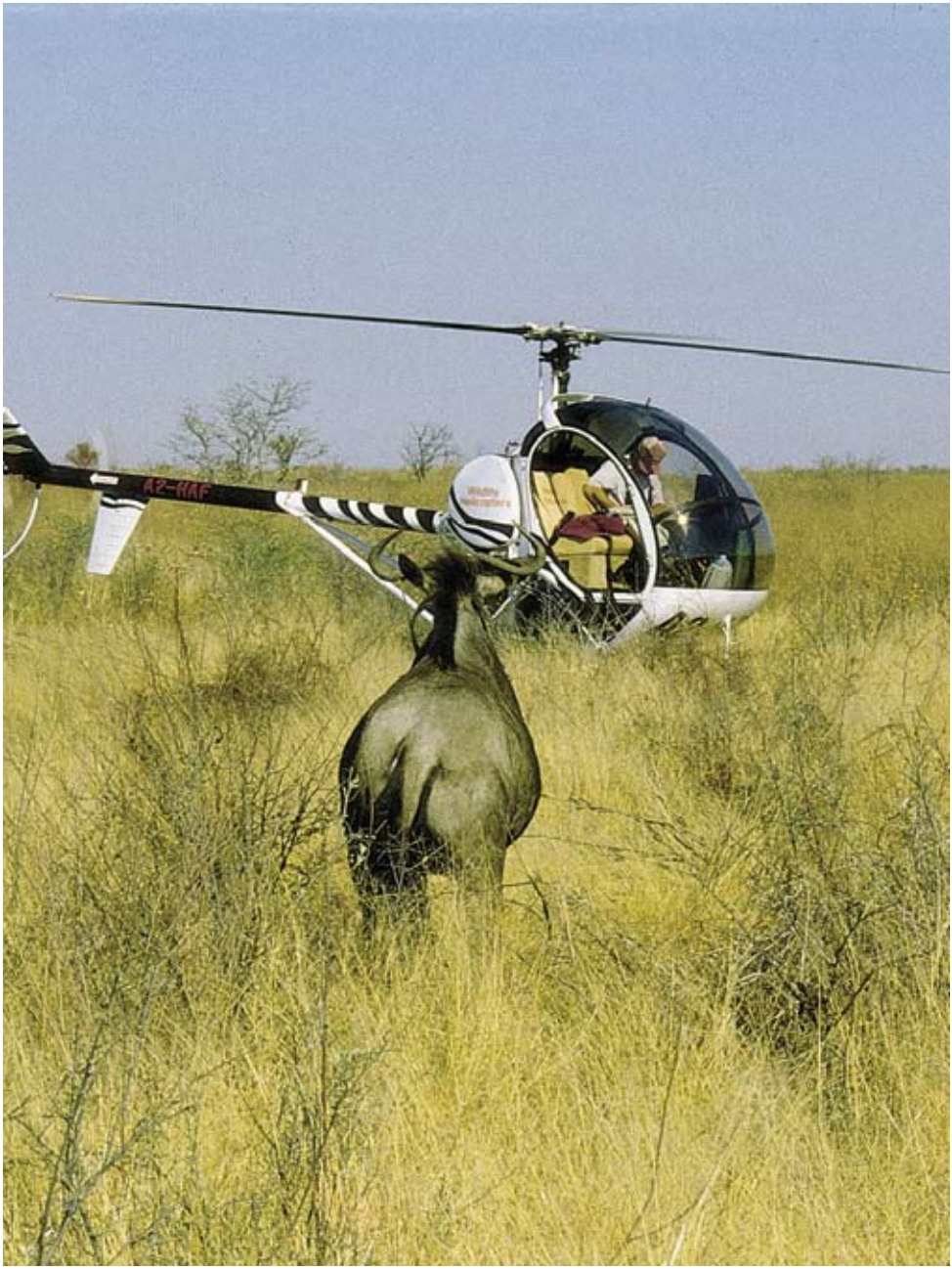
2.3.5 DWNP approval

To obtain DWNP approval to game ranch on a particular piece of land they require that a management plan be submitted to their district office. The Department issues guidelines which state that the plan should cover:
Project background,
Project objectives,
Technical plan,
Start-up,
Production process,

Marketing,
Financial plan (excluding freehold land)
Employment and job creation,
Localisation and
Any other relevant information.

There are a number of consultants in Botswana who are experienced in, and willing to assist in, preparing these management plans.

The National Policy on Agricultural Development, passed in 1990 but only recently implemented, allows for the fencing of communal land around boreholes. Guidelines have been given to the land boards by the Department of Animal Health and Production (DAHP) in the Ministry of Agriculture to assist in the demarcation of ranches. These cover areas such as carrying capacity, rental and lease agreements.



Helicopter - a very useful tool for wildlife management on game ranches

3 Environmental Principles and Management

3.1 Ecosystems and habitats

Ecology is a concept that describes how all the natural components of the environment function together and influence each other to sustain life. An ecosystem consists of living organisms and the non-living aspects of the environment (for example soil and climate) which act interdependently to influence one another and which are all essential for the preservation of life in a particular area. In one sense an ecosystem places biological and geographical limits on the concept, e.g. desert, savanna and bushveld can be regarded as different ecosystems, or an ecosystem can also be thought of as a collection of habitats, such as riverine woodland, papyrus swamp and seasonal floodplains as in the case of the Okavango Delta.

A habitat can be conceived as the living space of an organism or animal – a specific combination of natural elements such as vegetation, water, and breathing space in which an animal survives and can hopefully thrive.

3.2 Ecological principles

Ecosystems are dynamic and change continually. They should be able to exist quite naturally, without interference from man. A disturbance or change in any facet of an ecosystem has a ripple effect on the whole system and will lead to natural adjustments. In effect the system may be said to be in a kind of equilibrium. Two qualities are important: stability – resistance to change; and resilience - the ability to recover from change. Understanding these effects and their likely time scales are of great importance in managing a game ranch. Resilience is a valuable quality that management should aim to preserve or enhance.

The ecosystem concept gives rise to several principles which should be understood and applied whenever we interfere with natural systems under the guise of management. Game ranching, like forestry or agriculture, is a prime example of such interference. Many of the problems on ordinary farms and game ranches could be prevented if more ranchers understood the ecosystem concept and applied the principles which arise from it.

3.2.1 Plant succession

Any area, owing to a combination of its basic characteristics, e.g. soil, climate, slope, drainage and incidence of fire, will tend towards natural climax vegetation. For example, in Botswana this could be mopane woodland or teak forest in the northeast, or mixed savanna in areas of the Kalahari. Whichever it is, it is the result of a progression from bare ground through several intergrading phases, any of which may be interrupted by natural events or human interference, with the result that an intermediate vegetation type may predominate and be maintained. Overgrazing, for instance, will result in bush encroachment of grasslands in some cases, while elephants are famously known to convert woodland to grassland if their numbers are excessive in a certain area.

The purpose for which a game ranch is managed (for example tourism, hunting or venison production) will determine which stage of succession is to be created and maintained by habitat management and the manipulation of the game populations. Both over-utilisation and under-utilisation can be equally detrimental. Rather than trying to achieve a stable situation, good management aims at maintaining change within reasonable limits and allowing natural resilience to come into effect. Irregular, large-scale events which at first may appear disastrous are important in invigorating an ecosystem, particularly its vegetation. In a bushveld situation these episodes might be severe drought, heavy flooding, prolonged frost or an exceptionally hot fire.

3.2.2 Population dynamics

This is a complex subject which can be highly theoretical, requiring an understanding of mathematics and statistics beyond that of most ranchers. However, certain aspects are based on obvious principles and should be clearly understood. The main aspects of game populations which are particularly important in game ranch management are growth, age and sex composition, social organisation and behaviour of the population. These aspects can act singly or in combination, but all are linked to the population's potential to increase.

Population growth

Since fencing should eliminate immigration of animals to a game ranch, the only way, apart from purchase of live game, in which numbers can increase, is through breeding. Almost all game species have the same theoretical pattern of population growth (Fig 3.1). Only the rate varies, with larger species normally taking a longer time period to reach equilibrium. Three distinct phases are involved:

- establishment – a period of slow increase,
- exponential (rapid) growth – if conditions allow (adequate forage, space etc. and predators controlled), and
- equilibrium – when numbers oscillate around the ecological carrying capacity.

From the graph it can be seen that a population starting from a small number will take several years to grow to a useful size, but that if a herd of 25-40 individuals is the starting point equilibrium is reached much more quickly. This is important to remember when buying or capturing "start up" stock. It is economically sounder to begin a game ranching venture with larger numbers of a few species rather than small numbers of many species. Harvestable populations and thus income are achieved more quickly.

Population growth rates are important, especially when determining levels of offtake. Calculating these rates involves mathematical equations beyond the scope of this handbook, but a basic understanding will allow the principles to be applied in a sufficiently practical way.

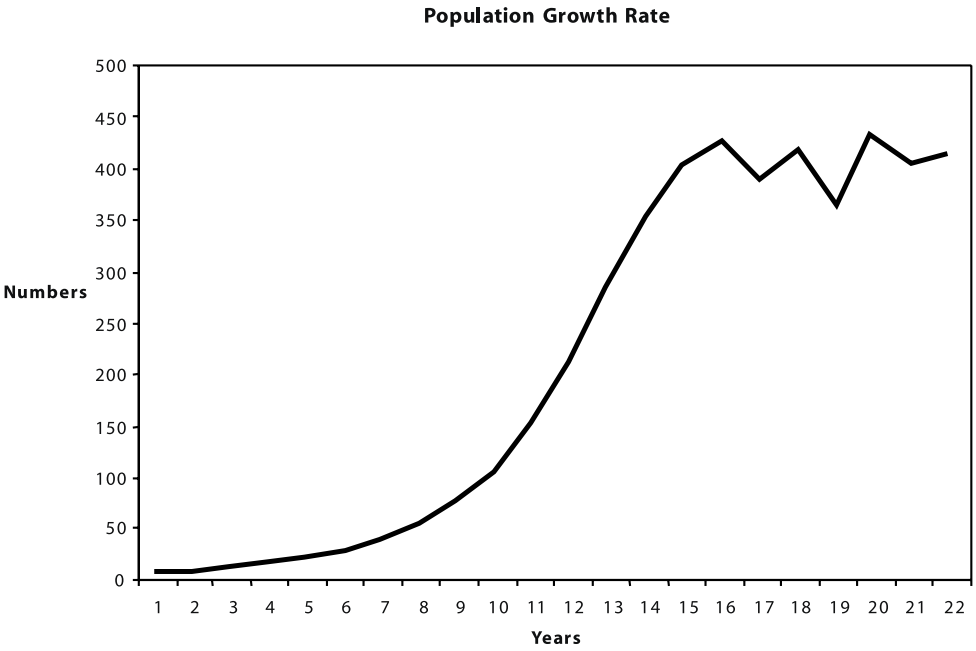


Fig 3.1 Population growth curve

Wild populations have a potentially high growth rate *(inherent growth rate)* when they are not subject to environmental or management limitations, but in practice environmental and/or management pressures often do not allow this potential to be reached. The growth rate indicated by the steep portion of the curve in Fig 3.1 is the exponential growth rate, i.e. the growth rate at a given point in time. This is the value that should ideally be used in management calculations, however, in most cases a simple approximation, the finite growth rate, can be calculated quite easily and is good enough for most purposes.

The finite growth rate (λ) is obtained by dividing the results of two consecutive annual counts (y/x), then multiplying the result by 100, then subtracting 100 to get a percentage growth rate. For example:

impala count in July 2004 (x) = 200, impala count in July 2005 (y) = 270; y/x = 270/200 = 1.35; (1.35 X 100) – 100 = 35% annual growth rate.

A mathematical constant (0.7) can be used to calculate the approximate time needed for a population to double; e.g. a population with a sustained exponential rate of increase of 10% will take 0.7 ÷ 10% (0.1) = approximately 7 years; a rate of increase of 3% will give a doubling time of 0.7 ÷ 0.03 = 23 years; and a rate of increase of 25% will cause the population to double in approximately 3 years (2.8).

Birth rate

Birth rate is calculated as the number of living progeny produced per adult female over a given period (normally a season or year). The species found on typical game ranches normally breed once per annum and have single young, except on rare occasions. Females of different species reach sexual maturity at different ages. They are less fertile in their first year, but after that, in theory, they should produce a calf each year. Under good conditions a calf crop of 85% (85 calves per 100 adult females) should be possible. There can be many causes of a poor calf crop. The majority can be influenced by management. They may include:

- Females in poor condition - veld condition (overgrazing, drought), mineral deficiencies;
- Unbalanced sex ratios – too many or too few breeding males;
- Incorrect herd social structure – particularly age structure;
- Heavy predator pressure – losses of newborn calves;
- Poaching.

Mortality

Mortalities occur mainly at two stages – very young animals and old animals. Where predators occur, the mortality of the annual calf crop is naturally about 50% in the first year of life. Old animals also die in larger numbers, particularly when harsh conditions prevail, such as at the end of the dry season or during droughts. However, post-weaning and throughout adulthood mortalities should be very low (<2%) on ranches where large predators are excluded or kept to a minimum.

Since a population decline can only be the result of decreased productivity or increased mortalities, studies of the productivity of game can help to determine the problem in a particular population. If there is little or no growth and the productivity is healthy, then mortality is too high. If the number of mortalities on a game ranch is particularly high amongst adult animals but normal among younger animals, then the problem is likely to be excessive hunting pressure because other important mortality factors usually affect the younger animals more heavily. If the population decline is the result of a shortage of food or poor habitat, there is a characteristic increase in mortalities among young animals, often also linked to lowered productivity, in other words low calving percentages. Where excessive mortalities and/or subnormal productivity is determined or suspected, the causes must be determined and eliminated by correct veld or population management.

Sex ratios

An imbalance in the sex ratio of animals often leads to a poor mating frequency, especially in animal species where one male, for example, tries to maintain and serve a harem of ten or more females as well as keeping other males out of his territory and thus away from his breeding group. The male can thus become physically too exhausted to breed, although he maintains his territory and harem, or he spends so much time defending his territory that he does not have enough time to mate

with all the females when they are in œstrus. A rough guide to recommended sex ratios is given in Table 3.1.

3.2.3 Ecological capacity

More discussion and division has occurred regarding the concept of carrying capacity than any other facet of game ranch management. It is, of course, of vital importance to understand how many animals can be carried on a ranch because of the ecological and economic consequences which depend on it. Modern opinion is that the term "carrying capacity", which originated in livestock management about 75 years ago, should not be applied to game ranch management. A great deal of research has taken place recently in this respect and new methods of calculating the optimum stocking rates of various types and combinations of wildlife on different types of veld are now available. These lead to the definition of ecological capacity and mainly require detailed habitat monitoring and assessment, ideally over a long continuous period. For our purposes the following brief definition should suffice.

"The ecological capacity is the ability of the vegetation to support animals and maintain them in a healthy and reproductive state without deterioration of the vegetation in the long-term."

The term ecological capacity is preferred because the stocking density of game on a ranch is not only limited by the available food resources, but also by their social behaviour such as territoriality or preferred group size. It is generally expressed as the number of hectares necessary to support one large stock unit (LSU) - one LSU being taken as the equivalent of a steer of 450 kg body weight growing at a rate of 500g per day on natural grazing. LSU values (Table 3.1) are allocated to the animals on the basis of their mean metabolic body mass relative to cattle. Mixed feeders utilise graze and browse at different times of the year and the approximate ratios of each are usually given as percentages, which can change depending on the habitat.

The ecological capacity of a game ranch is usually composed of a grazing and a browsing capacity. Herbivorous animals are classified according to their feeding habits and food plant selection. All animals are to some extent selective. When placed in an area with a continuous grazing system, animals will favour those areas offering the best food resources. Cattle can be forced to be unselective feeders with a rotational grazing system using paddocks. However, wildlife is usually kept in a continuous grazing system and different species will display a more or less selective feeding behaviour. They are usually classified accordingly into bulk grazers, selective grazers, mixed feeders and browsers.

The ecological capacity fluctuates naturally in relation to changing environmental conditions and as a result of previous management practices. For example, a series of drought years can reduce the capacity substantially, whereas sound wildlife management practised over many years may increase it. The estimated ecological capacity of a ranch should therefore be re-evaluated every few years, based on data obtained from game and vegetation monitoring programmes.

Grazing capacity

Grazing capacity refers to the number of grazing animals that can be supported by the vegetation in the long-term. The grazing capacity is influenced by many factors, such as the soil, slope, altitude, climate, type of vegetation and former management practices, such as fire and stocking rates. Annual rainfall has the greatest impact on the grazing capacity in the drier parts of Africa, such as Botswana.

Detailed methods exist to estimate the current grazing potential of an area. These involve intensive studies of the vegetation and focus on the grass species composition and determination of the state of health of the grass layer. Alternatively, the state of the vegetation of a ranch can be subjectively assessed and compared to areas of similar vegetation type

in the vicinity. Comparisons should be made against the full spectrum of grazing conditions, i.e. with ungrazed sites, well managed and severely depleted sites. Vegetation that has been excessively overgrazed or burnt will be in a depleted state and will have a lower grazing capacity.

The recommended stocking rate for cattle (without supplementary feeding) for that particular region is then taken as a starting point to calculate the grazing capacity for a game ranch. For several reasons, however, this does not equal the ability of the vegetation to support game: (i) Wildlife performs best if the stocking density is kept below the ecological capacity of its environment. At this stocking level, competition for the available resources is low and maximum sustained yields can be obtained from the game population. (ii) In natural wildlife areas, vegetation can support more wildlife than livestock because large game herds naturally migrate over vast areas, exposing the vegetation to a short period of heavy grazing followed by a prolonged period of rest. On fenced ranches, migration is impossible. Rotational grazing systems have been developed for livestock that simulate a migratory grazing pattern. However, game cannot be rotated easily, which results in a continuous grazing pattern. (iii) Another important point to consider is that cattle are bulk grazers, whereas many wildlife species are selective grazers. Where a cow utilises an entire tuft of a palatable grass, a sable antelope for example would nibble only on the tips of a few of the leaves of the same grass tuft. Although a wide game spectrum will utilise a greater variety of food plants, the overall utilisation of plant matter will be lower with wildlife than with cattle on the same ranch.

Therefore, total cattle LSU must not be converted directly into LSU for game as this would result in overstocking, which would have detrimental effects on the game populations and on the grazing capacity in the long-term. Overgrazed vegetation will take many years before it is restored to its original state. Therefore, it is recommended as a rule of

thumb to take only 70 % of the predetermined cattle LSU as the grazing capacity for game. This figure must be kept still lower if the subjective comparison to other sites in the vicinity has revealed that the vegetation of the ranch is not in an optimum condition owing to, for example, previous overgrazing with livestock.

Game ranches are usually stocked with a variety of game. When selecting the species care should be taken to include sufficient bulk grazers in the stocking programme. They feed on coarse and tall grasses, which are mostly ignored by the selective grazers. When these coarse grasses are not regularly removed, they will become moribund and form dense stands, which are not utilised and become a fire-hazard. A widely accepted recommendation in southern Africa is to stock an equal amount (LSU) of bulk grazers and selective grazers. On game ranches in Botswana, where buffalo are not readily available, it is often difficult to keep sufficient bulk grazers. Zebra or even cattle can however be substituted as bulk grazers.

Browsing capacity

No reliable, objective methods exist to estimate the browsing capacity of Botswana bush. Local experience and discretion must be used. As a rough guide, a 2:2:1 ratio of 2 LSU bulk grazers: 2LSU selective grazers: 1LSU browser is often recommended as a game ranch stocking scenario.

Over-utilisation of browse (except when caused by elephants) is not as damaging in the long term as over-grazing. The latter leads to soil erosion and rapid irreversible change. Overstocking with browsers is relatively easily noticed (browse lines, broken branches, etc) and the condition of the browsers deteriorates rapidly owing to malnutrition, e.g. high mortality rates frequently occur in kudu during winter as a result of over-browsing.

Bulk grazers	Mean adult mass m	f	Recommended sex ratio m:f	LSU equivalent	Preferred feed	Water dependency
Cattle	750	550	-	1	Tall grass	+
Buffalo	800	550	1:20	1	Tall grass	+
Ostrich	150	110	1:4	0.25	Unselective	-
Waterbuck	260	180	1:10	0.5	Tall grass	+
White rhino	2100	1600	1:4	2.5	Short grass	+
Zebra	350	300	1:6	0.75	Unselective	+
Selective grazers						
Blue wildebeest	250	180	1:10	0.5	Short grass	+
Red hartebeest	150	120	1:10	0.4	Short grass	+
Reedbuck	80	50	1:5	0.15	Tall grass	+
Roan antelope	280	240	1:10	0.65	Tall grass	+
Sable antelope	230	210	1:15	0.55	Tall grass	+
Tsessebe	140	125	1:10	0.4	Short grass	+
Warthog	100	70	1:10	0.2	Short grass/ omnivore	+

Mixed feeders						
Eland 30:70	750	500	1:15	1	Unselective	-
Gemsbok	240	210	1:10	0.45	Short grass/ some browse	-
Impala 50:50	50	40	1:10	0.15	Short grass/ browse	+
Springbok	40	35	1:12	0.08	Short grass	-
Browsers						
Black rhino	850	880	1:4	1.65	Mixed browse	+
Bushbuck	50	30	1:6	0.15	Mixed browse	+
Duiker	15	15	1:1	0.1	Mixed browse	-
Giraffe	1200	850	1:3	1.5	Browse	-
Kudu	350	200	1:10	0.5	Browse	+

Table 3.1 Ecological parameters of most commonly ranched species

3.2.4 Sustainable yield

Under ranching conditions most of the factors that cause mortalities or limit the numbers of animals should be eliminated, or at least controlled and minimised. This leads to the creation of an available excess of animals each year that is normally harvested in one or more of the ways mentioned earlier. The target for this harvest is the maximum sustainable

yield (MSY), which is normally the maximum number of animals that can be removed from the system without causing disruption or decline of the breeding population. Variations may occur, e.g. when managing specifically for trophy production or sales of breeding stock, but we will remain with the basic principle.

MSY can most simply be described by referring again to Fig 3.1. If a population is reduced from the ecological capacity to some point on the steep portion of the curve, it will, if conditions remain favourable, grow to reach the ecological capacity again. The biggest off-take that will still allow the population to recover fully in one year is the MSY. Under excellent conditions this can be quite substantial, e.g. approaching 50% in impala.

In practice, the off-take will vary according to prevailing conditions, but it can also be manipulated to stimulate (or suppress) population growth. With regular game counts it can be determined quite quickly whether the harvesting levels (quota) are too high or too low and they can be adjusted to comply with the predetermined objective.

The complex mathematics involved in the theoretical calculation of off-takes puts them outside the range of this booklet, but a simple basic principle is that the MSY of a population at ecological capacity (K) is in theory achievable by initially reducing the population by 50% and then harvesting at half the maximum inherent growth rate per annum.

3.2.5 Social behaviour

Each wildlife species has a characteristic pattern of social behaviour. This must be taken into account when stocking a game ranch because animal behaviour has a profound effect on stocking rates, habitat management and the co-habitation of different species. Herd size and composition, family units, dominance hierarchies, home range and

territoriality, breeding behaviour and other seasonal changes are just some of the many considerations. Habitat type and distribution have a major influence too, e.g. species which live in large herds tend to inhabit open areas, whereas solitary, crepuscular species are mainly found in closed woodland and thickets.

Some species have strong herd structures and tend to be more territorial, such as roan, sable and other low-density species. This is a key factor in their management because they often do not compete well with other species when they are forced to live in too close contact. Others such as eland and buffalo are more gregarious and less sensitive when it comes to social limitations. Zebra form small strict family groups of 6-8 individuals with one stallion. These are kept intact even when they form aggregations of thousands as in the Makgadikgadi migration.

3.3 Environmental management

3.3.1 Management objectives

A set of objectives for managing the veld and habitats should be put in place. These might be:

- To achieve and maintain the ecological capacity of the various habitat types
- To monitor habitat condition
- To set acceptable limits of change
- To rehabilitate any degraded habitats
- To ensure optimum economic returns (maximum sustained yield)

Habitat condition

The various habitats occurring on the ranch should be assessed for ecological condition. This evaluation should include a basic resource inventory covering the land types (topography), soil characteristics, vegetation and water resources. This can be done at various levels of detail. Professional ecologists using sophisticated computer software can

be engaged to provide a full ecological evaluation of the ranch. At the other end of the spectrum an experienced rancher can make a rapid assessment of key indicators. The abundance of annual grass species, forbs and certain woody species can indicate the condition of the veld. Poor condition could be the result of overgrazing, drought, soil degradation (e.g. erosion), bush encroachment or fire (excessive or too infrequent).

Soils and vegetation map

It is important to know the distribution of the various soil and vegetation types on the ranch. This can be done inexpensively from aerial photographs, with some ground truthing for positive identification and evaluation. A vegetation map is essential to determine the extent of each habitat type in order to plan a stocking programme, implement a monitoring programme or establish infrastructure. Roads, for example, should follow vegetation boundaries (ecotones) where possible, to take advantage of the higher use made of these areas by animals.

Bush encroachment

This can be defined as the growth of excessive numbers of indigenous woody plants to the detriment of grassy areas. It is invariably caused by overgrazing or incorrect burning regimes, i.e. poor management practices. Common examples of such encroachers are moselesele *(Dichrostachys cinerea)* and mongana *(Acacia mellifera)*. Bush encroachment leads to a decrease in grass cover and the grazing capacity of an area can therefore be reduced drastically. Any consequent increase in available browse will not compensate for the loss of grazing.

Control or elimination of bush encroachment can be very problematical and expensive. Chemical and mechanical methods can be used to remove encroaching woody species. Examples of the latter are ring barking, repeated cutting and uprooting (by hand, by chains or even by bulldozer). It is far preferable to use biological means of control where possible, i.e. fire and browsing.

3.3.2 Fire

Fire has been a natural part of southern African ecosystems for thousands, if not millions, of years. All vegetation types have adapted to the effects of fire. Using fire as a management tool, however, is a complex subject with an immense volume of research findings, many of which are inconclusive and some are downright contradictory. Of course it depends to a large extent on the habitat type under discussion because they all have individual and varying tolerance of fire.

Fire can be used on a ranch to improve veld condition by removing moribund material, preventing bush encroachment, increasing habitat diversity and to create firebreaks. Everyone is aware that animals are attracted to fresh grass growth stimulated by a fire. This is because the palatability and nutritional value of grasses are enhanced for a limited period after burning, e.g. the crude protein content may be doubled. Up to a third of a game ranch can be burned each year, but obviously in rotation. Because of the inevitable incidence of droughts and wildfires, any burning programme on a ranch must be adaptive. One basic rule of thumb, however, is that prescribed burning is not advisable in areas receiving less than 400mm of annual rainfall and must be undertaken only with careful planning when the rainfall is less than 550mm p.a., i.e. most of Botswana.

Impact of fire on grasses

Fire and grazing are both means of defoliating the grass sward. Most palatable grass species are adapted to moderate utilisation. These grasses become choked with moribund material and lose their vigour when they are not defoliated over an extended period. This situation then favours the growth of tall, fibrous grasses. Excessive utilisation, on the other hand, depletes the storage reserves of the palatable grass species. These palatable grasses are then weakened and become replaced with mostly unpalatable grass species upon which selective grazers

are reluctant to feed. Where grazing is limited or selective, regular fires are necessary to remove old grass growth, but with heavy grazing, fire should be withheld.

Shortly after a fire, grasses will produce a green flush to keep alive. This requires the grass plant to draw nutrients and energy from its storage organs. This green flush is highly attractive and nutritious to grazing animals. When it is grazed off, the grass plant must further draw on its reserves to survive prior to the onset of proper growth in the early rainy season. When a grass plant is repeatedly exposed to such treatment, its reserves become depleted; the plant is weakened and is eventually replaced by less desirable grass species or forbs. This results in a decline in the condition and grazing capacity of the grass sward. To avoid these effects, the burnt areas must be protected from high grazing pressure shortly after a fire. The green flush that is produced on the burnt area must exceed the short-term forage requirements of the game that is attracted to it. To achieve this, an area that is burnt must be sufficiently large, or several areas must be burnt simultaneously.

The deliberate use of fire to stimulate an out-of-season green flush for grazing is viewed as an unacceptable practice by most pasture scientists in southern Africa. The combined effects of over-grazing, increased water run-off, increased soil erosion and decreased vigour of the grass sward can lead to widespread and drastic deterioration of the vegetation. However, heavy grazing of the green flush after a fire may be beneficial when tall fibrous grasses dominate the grass sward. Such a system of burning and grazing will deplete these grass species, and they will gradually be replaced by grasses better suited to grazing. Ranchers refer to this process as 'sweetening of the land'. The process is effective only under exceptional circumstances in Botswana and should not be applied generally.

Impact of fire on woody savanna vegetation

Where man-induced burning is minimised most burns are caused by lightning. African savannas with a dry season from May to October are extremely prone to this kind of fire source. Other major factors in the frequency and intensity of fires are fuel load and fuel moisture. Moist savanna (>600mm annual rainfall) is much more prone to "natural" fires because fuel loads build up more quickly. Annual or biennial burns are the natural regime in moist savanna. In drier savanna (<600mm annual rainfall) the natural state is far less frequent fires, between 3 and 5 years, except in periods of unusually high rainfall when the moist savanna regime might come into play.

It can be simply stated that "cool" fires maintain the structure and species composition of woodlands, whereas "hot" fires tend to convert the woodland towards a more open savanna. Fire tends to decrease the height of shrubs and small trees, benefiting most browsing species, e.g. impala and kudu. Where most research has been carried out, in naturally grazed woodland in Zambia and South Africa for example, too frequent burning (annual or biennial) has been shown to reduce the basal grass cover and increase the proportion of less palatable grass species. The less frequent but more intense burns of the "natural state" result in much greater species diversity and a changing pattern of burnt areas which is suitable habitat for a wide range of animals.

3.3.3 Aims and procedures for controlled burning:

Controlled burning can be successfully used to achieve the following objectives:

Primary aims:

- Remove moribund grass material;
- Control the encroachment of undesirable bushes and trees;

- Force trees to coppice, and thereby lower the canopy into the reach of browsing animals;
- Remove potentially dangerous fuel loads, and reduce the subse quent impact of wild fires;
- Create firebreaks and
- Remove unpalatable grasses to stimulate utilisation.

Secondary aims:

- Reduce tick burdens;
- Improve visibility (æsthetics) and
- Facilitate hunting.

Timing of burns

Actively growing plants are more susceptible to damage by fire than dormant plants are. When a scorching effect on the trees and bushes is desired to reduce woody density, a fire should be applied when the woody vegetation is actively growing. When a fire is needed to remove moribund grass material to stimulate growth and vigour of grasses, a fire should be applied when these plants are dormant.

Fires applied during the cool dry season (May to August) do not burn as hot as fires in the hot dry season (September to November). Some green plant material is still present during the cool dry season, which limits the available fuel-load at this time. Also, during this season the daily temperatures are lower than during the hot dry season. The following effects can be expected depending upon the timing of a fire:

Early fires (before August): encourage the growth of woody plants, but hamper grass growth because the grasses are not protected at the time of seeding. Early fires decrease seed dispersal and the translocation of nutrient reserves to the root storage organs.

Mid-season fires (August to September): remove some moribund grasses but also inhibit the growth of other grasses when these are not yet

dormant, and will damage the smaller woody plants. Fires at this time of year can be hot, and will damage emerging leaf buds.
Late fires (October or later): damage woody plants, remove moribund grass material, and facilitate grass re-growth.

Intensity of fire

Fires applied at midday burn hotter than fires applied early in the morning when some dew is present, the ambient temperature is lower and the relative humidity of the air is higher. The heat intensity of a fire also depends on the wind direction at the time. A fire burning with the wind is referred to as a headfire, whereas fires burning against the wind are referred to as backfires. Headfires burn much hotter than backfires, but move rapidly through an area and have their point of highest heat intensity located high above the soil surface. Beneath a headfire, the dormant grass buds are not exposed to high temperatures and are seldom damaged. Backfires, however, move slowly, and have their point of highest heat intensity close to the soil surface. The dormant grass buds are therefore exposed to the high temperatures for longer and are scorched to a greater extent by backfires than by headfires. Woody vegetation, on the other hand, is scorched to a far greater extent by headfires.

3.3.4 General guidelines for burning programmes

Depending upon the objective of controlled burns, the following general guidelines can be applied regarding their intensity and timing:

To remove moribund grass material, a late fire within 2 days after the first rains is recommended. As the soil is slightly moist, some litter will be retained to provide protection against wind and water erosion.
A headfire should be applied that moves rapidly with the wind. It should be a cool fire and therefore is best applied in the early morning or late afternoon.

To control tree and bush density, a hot headfire should be applied at midday during September/October. However, fire alone is seldom effective in achieving a high kill rate of woody plants. To achieve this heavy browsing pressure should follow soon after the fire. This is only practical with the use of domestic goats in small fenced camps, but is unlikely to be achievable on a game ranch.

If the aim of the burn is to control only the undergrowth in woodlands, while protecting the larger trees, or to stimulate the production of leaf material at lower heights, a cool headfire should be applied in the early morning during June and July. Such a fire tends to burn in a patchy manner and has to be re-ignited in many places.

Firebreaks are created to protect an area against the incursion of wild fires. If burnt too early, an excessive amount of vegetation remains that may support a fire later in the season. A balance is needed between burning sufficiently late to attain an adequate scorching effect, and having a network of firebreaks in place prior to the anticipated start of the wild fire period. Discretion is necessary depending on the timing of the last rains, but firebreaks can usually be burnt in June.

To stimulate the utilisation of coarse swards and ultimately lead to a change in grass species composition ('sweetening'), hot headfires can be applied during the early or mid dry season (June/July/August).

Fire management in various vegetation types in Botswana

- Mopane woodland: supports limited grazing, but the grasses are usually sweet and nutritious. It is therefore unlikely that there will be a build up of moribund material. Burning is likely to be necessary to inhibit bush encroachment and encourage grass growth. Often there will be insufficient material to burn, but mopane is fire sensitive and young bushes can be reduced with

headfires if there is enough combustible material.

- Teak/*miombo* woodland on Kalahari sand: fire must not be totally excluded or bush encroachment will occur. It probably will benefit from burning to remove moribund material every three or so years. Fires should not be hot or damage to mature trees will occur. Burn in July at the latest, or immediately after the first rains.
- Eastern mixed acacia/*combretum* woodland: burning prescription depends on rainfall levels. Soils are more prone to capping and erosion if burning is excessive. Preferably burn only in wetter years when fuel loads are sufficient to produce a hot enough burn to prevent bush encroachment and improve browse.
- Kalahari mixed shrubland: sandy soils not degraded by fire. Most grasses have deep roots and are able to flush well after a burn. Only burn in wetter years to limit bush encroachment.
- Dry grasslands: normally below 450mm rainfall and should not be burned. If the grassland has been under-grazed and moribund material builds up there will be a decrease in vigour of the sward and tall, rank grasses will begin to predominate. "Sweetening" the grassland by careful burning followed by heavy grazing of the green shoots may reduce these and stimulate more palatable species which would be useful.
- Floodplains: rank, coarse grass species can be burned early in wetter floodplains to produce sweeter grazing and provide useful firebreaks. In drier floodplains, on sandy soils with sparser grasses, burning should not normally be necessary.

3.3.5 Habitat monitoring

It is absolutely essential to monitor the environment on a game ranch. Successful management depends on recognising trends and responding to them (adaptive management). This can only be achieved through a long-term monitoring programme. It is not necessary to instigate a complex system requiring professional ecologists, though some scientific

advice at the outset might be an advantage. Any competent rancher can collect the required information, interpret it and then act accordingly by adjusting his management practices.

A basic set of data collections for a Botswana game ranch should include:

- rainfall;
- incidence and distribution of fire;
- soil erosion;
- species composition, dynamics and cover of woodland and grass land and
- wildlife abundance and distribution

Habitat types

As mentioned earlier, a detailed vegetation map of the ranch should be drawn. This should normally be derived from aerial photography. Standard aerial photographs at a scale of 1:50,000 are available for many areas from the Department of Surveys and Mapping in Gaborone. These form an excellent basis for preparing a list of broad habitat types. These may be similar to:

- riverine thicket
- mopane scrub
- mixed woodland
- shrubland
- floodplain
- old lands
- dry grassland

Rain gauges

In Botswana rainfall is the environmental variable that has the greatest impact on the productivity of the vegetation and as such on the ecological capacity. It is imperative for a ranch to record the annual precipitation

in order to be able to adjust the stocking density in time before the vegetation and/or game are negatively affected by drought conditions.

Because of the variation in rainfall caused by localised showers and thunderstorms, it is advisable to have a series of rain gauges strategically situated to cover as many habitat types as possible. Rain should be recorded on a daily basis. The timing (frequency), spatial distribution and amount of rainfall are all important parameters to record. A rain gauge is placed on level terrain at a site where it is not obstructed by trees, buildings, radio antennæ, water tanks etc. One rain gauge per 1,000 ha is sufficient for monitoring purposes.

A reduction in annual rainfall will lead to a temporary reduction in the ecological capacity of the vegetation. In such situations a reduction in the stocking rate is necessary. As a rule of thumb, it is recommended to reduce the game numbers that have been set as the minimum numbers by a further 5 % for every 50mm that the annual rainfall has dropped below normal. The annual rainfall is known at the end of the rainy season in April, but the limitation in the ecological capacity will become obvious only later during the hot dry season from September to November. The harvest must therefore be planned early and timed in such a way to remove sufficient game before the ecological capacity is exceeded.

Incidence of fire

Every fire that occurs on a ranch must be recorded including the date and cause of the fire. The burnt area should be shaded on a map of the ranch. Prior to the start of the following burning season, the past history of each site that is considered for the coming burn must be evaluated to avoid the site being burnt excessively.

Soil erosion

This is obviously much more important in some areas, e.g. the Tuli Block

in the Eastern hardveld is more prone to soil erosion than the Kalahari sand areas around Jwaneng. There are a few simple ways of measuring the loss of soil from a specific place and two suggestions are shown in Fig 3.2.

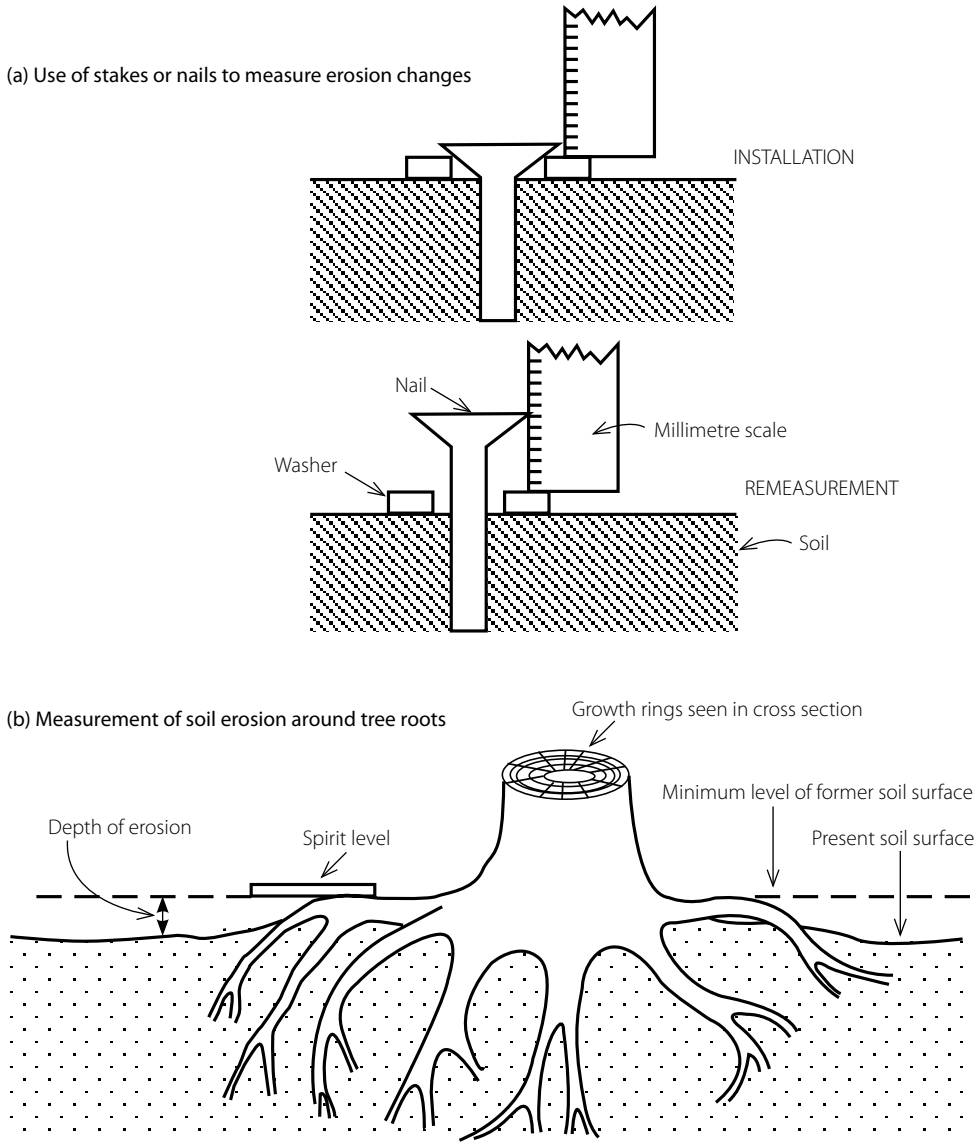


Fig 3.2 Measuring soil erosion

3.3.6 Vegetation monitoring

Monitoring the vegetation on a ranch is an essential component of wildlife management. Monitoring must be aimed at detecting trends and changes that take place over time. For effective monitoring, a baseline index of the vegetation is required against which the future state of the vegetation can be compared.

Savannas tend to fluctuate between being dominated by grasses or trees. Heavy browsing and frequent hot fires shift the balance in favour of open woodland with greater grass cover. It is advisable to monitor both the tree and bush density and the grass species composition to maintain this equilibrium in the most desirable state.

Monitoring grassland

Grass species differ from one another in their reactions to grazing pressure. Some grasses will thrive only when they are very lightly utilised, and these species will disappear from an area when it is heavily grazed. Other grasses are stimulated by moderate grazing pressure, but disappear when under- or over-utilised. Other grasses will only become dominant in an area that is severely over-utilised. If these ecological responses of the grass species are known, then it is possible to deduce the grazing history and the current condition of a grass sward simply by determining which grass species are dominant. One can then also monitor the grass species composition over time. A change in the grazing management will be reflected by a change in the grass species composition, which will indicate if the condition of the sward is improving or deteriorating. Even without expert scientific knowledge, competent ranchers should be familiar with the vegetation condition of their ranches. They will be able to identify some grasses or forbs that indicate good and poor grazing conditions. A simplified version of the scientific methods can then easily be conducted, as outlined below, without professional assistance.

Approximately 6 grasses need to be identified which can serve as key indicators of the vegetation condition in a particular area. One or two of these grasses should indicate under-utilised swards, one or two grasses healthy and well-utilised swards, and one or two should indicate over-grazed or deteriorated swards. A rancher then selects several monitoring plots of approximately 30 x 30m which are representative of the surrounding vegetation. Three to four such plots are sufficient per major vegetation unit. Within each plot, 200 points are evaluated. This is done by walking in a meander or spiral pattern through the plot. At every second step, a walking stick is put down to the ground. The plant nearest to the stick is identified as either one of the key plants or as another plant and is counted. After 200 such recordings, the percentage contribution of each key grass within the grass sward is calculated. Plots are monitored at the same time every year, best during early summer, when most grasses are in flower or seed and are easily identified.

Results of plots belonging to the same vegetation unit can be combined and are compared with those of preceding years. This may reveal a gradual increase or decrease in the percentage contribution of certain key grasses. If an increase is seen in the grasses indicating under-utilisation, then grazing pressure and/or the frequency of controlled fires can be increased. If the grasses that indicate over-utilisation become more abundant with time, then the stocking rate should be reduced well below the mean stocking rate for one or two years and fire be simultaneously withheld so that the vegetation can rest. During times of drought, grazing pressure on the vegetation is effectively increased and can result in a rapid decline in the vegetation condition. Animal numbers should be reduced in advance to avoid this situation.

Results must be interpreted with caution. Fluctuation will be normal and only if a marked change or a consistent trend over several years is seen, should action be taken.

High grazing pressure may occur following burning of an area. If a sharp decline in the vegetation condition of a site is detected following a controlled burn, then the area burnt is too small and is causing an excessive concentration of grazing animals. The area concerned should then be protected from fire for a few years until an improvement in the vegetation condition score is detected. The areas to which controlled burning is applied must also be enlarged.

Monitoring woodland

Fixed-point photography is a simple method to monitor changes in the tree/bush density. With this method the vegetation is photographed regularly and sets of photographs taken over the years are compared. Digital cameras have made this a simple exercise. Several fixed-points should be established in each major vegetation type, taking pictures of representative vegetation. In order to detect changes, such photographs need to be taken at the same time of year, in a consistent direction, with the same angle lens and from a consistent height. A commonly used method is to plant a metal pole permanently at the site to be monitored. These poles can have a camera-plate attached on the top on which the camera is rested when taking the photograph. A 50-mm lens is mostly used. The direction in which the photograph is taken is kept constant by using a compass. Altematively, a simple 1.5m tall pole can be planted some 20m away from a road. The photograph is then taken while standing on the verge of the road facing perpendicularly towards the pole and seeing the tip of the pole in the centre of the camera's viewfinder. Additionally, a person can stand in the vicinity of a prominent tree or the marker pole with a calibrated measuring stick to facilitate the evaluation of the photographs. Whichever method is used, consistency is important. It is recommended to take photographs annually during December, as most trees and shrubs are already in full leaf at that time while the grasses are not yet too tall.

All photographs of fixed points must be stored, and be compared with each other every year. Subjective assessments must then be made for any discernible changes in the tree and bush density of each site. The number of tree and shrub seedlings should be observed carefully as an initial indication of an increasing woody density. A decreasing woody density would be observed as a slow die-off of the woody plants, which may occur as the loss of whole plants, or of parts thereof, and will first be discernible in the appearance of dead branches. A rapid increase in sapling density together with a die-off of larger woody plants may indicate that hot fires have scorched the vegetation and caused plants to coppice.

If an increase or decrease in the woody vegetation is suspected, the photographic collection should be taken into the field. The site must then be compared with the surrounding vegetation to ensure that the trends seen in the photographs are indeed a reflection of the trends taking place on a wider scale. As no simple way exists to quantify an increase or decrease in tree density from a photograph, a subjective assessment of its severity has to be made instead. A 'considerable' change is understood here as an approximately 50 % increase or decrease in the woody density. If the tree and bush density increases considerably in any of the monitored sites, the respective vegetation block should be considered for burning during the following dry season. If a decline in woody density is noticed to the extent that the decline is considered undesirable, then fire must be withheld from that area and/or the browsing pressure be reduced.

Cheetah with young kudu - this species probably causes the most economic losses on Botswana game ranches

4 DEVELOPMENT OF INFRASTRUCTURE

4.1 Ranch evaluation

We have mentioned earlier the pros and cons of location, size and shape when it comes to choosing a game ranch. The ecological, legal and administrative factors have also been discussed. Game ranch development requires high capital inputs and the next logical step is to evaluate the ranch according to an inventory of existing and required infrastructure and facilities.

In Botswana the original game ranches were converted cattle ranches. A recent trend is to fence "new" land and create a game ranch from previously open range, either in communal grazing areas or in WMAs. Obviously then there are great differences between properties and their requirements. A thorough survey may be required to establish the amount, location and condition of any existing improvements such as fences, roads, water points, holding pens, loading ramps and buildings. Some of these may be of value in their present state, others might need modification and some may need removing. Depending on the objectives for the ranch, new infrastructure such as camps, fences, game viewing roads, boreholes, etc. will be required. These should if possible be surveyed and costed at the outset, particularly if financial assistance from schemes such as CEDA is required.

4.2 Required infrastructure

Some or all of the following fixtures will be required to operate a game ranch:

- Fences;
- Holding pens;
- Loading/offloading ramps;
- Roads;
- Airstrip;

- Firebreaks;
- Buildings/camps/staff accommodation;
- Water points and
- Power.

In addition, a great number of items of equipment are also necessary. The following list indicates some of the most substantial and expensive requirements:

- Machinery: generator, water pumps, windmills(?), workshop & tools;
- Vehicles: e.g. 4-wd pick-up, hunting car; game viewing car; tractor & trailer, grader;
- Office and communications: radios/cell phones, GPS, computer, aerial photos;
- Butchery equipment;
- Refrigeration/cooling facilities;
- Firearms;
- Veterinary requisites.

4.2.1 Fencing requirements

Animals challenge fences in different ways: by jumping, crawling, burrowing and breaking, according to species. Some species display more than one type of reaction to barriers. Table 4.1 gives an indication of how various species usually behave towards fences.

Jump	Crawl	Burrow	Break	No challenge
Eland Kudu Impala Waterbuck Zebra	Gemsbok Hartebeest Roan Sable Tsessebe Warthog Wildebeest	Warthog	Buffalo Elephant Giraffe Hippo Rhino Other large antelope bulls	Blesbok Springbok "mini" antelopes

Table 4.1 Animals and fences

The draft Botswana Game Ranches Regulations state that the land in respect of which a game ranch certificate is issued should be enclosed by a game proof fence as prescribed in the Third Schedule (Table 4.2).

Category	Type Of Animal	Minimum Height(M)	No. Of Horizontal Line Wires
(a)	Eland, Kudu, Waterbuck, plus all under (b) and (c)	2.30	17
(b)	Giraffe, Impala, plus all under (c)	1.83	12
(c)	Gemsbok, Ordinary Duiker, Oribi, Ostrich, Red Hartebeest, Roan Antelope, Sable, Springbok, Tsessebe, Wildebeest, Zebra, etc.	1.37	12
(d)	Buffalo, Rhino, Elephant, Hippo.	2.30	17 plus steel cables of minimum diameter10mm and/or 2 electrified strands at 0.5m and 1.5m above ground level.-

Table 4.2 Schedule 3 – Game ranch fencing requirements

Although different categories are specified for keeping different species, it is highly recommended that a 2.4m high fence with 17 strands should be the standard. The further addition of cables, mesh and/or electrified strands can be considered in special cases.

Materials

Poles: straining posts, standards and droppers

These can obviously be either wood or steel and sometimes a mixture is best in order to get the benefits of each material. Wood is cheaper and easier to fix securely in sand or soft soil. Steel lasts longer, is fire-, termite- and lightning-proof.

Straining posts should be set at 300 – 500m intervals in flat, sandy country, but much closer together in rocky and hilly terrain. They are also required where a fence changes direction. Standards should ideally be set at 25 – 50m intervals and droppers spaced at 1 – 3m. The spacing of straining posts and standards affects the elasticity of the fence, with wider spacing allowing more "give".

Wire: strands or mesh

A lightly galvanised smooth steel wire is generally recommended, 12 gauge (2.24mm diameter) is sufficient. Barbed wire is not recommended, though it is less likely to be stolen for snares. The lower wire strands are placed closer together than the higher ones, varying between 75mm at the bottom and 200mm at the top.

In certain situations, e.g. intensive breeding camps or where domestic dogs are common, it may be necessary to use diamond "jackal mesh" on the bottom of the fence. It is available in various gauges and mesh sizes and is not normally necessary above 1.5m from the ground, although it may need to be buried to a depth of 0,5m to be really effective.

"Veldspan" or similar products are specially designed mesh fencing materials which are available in a range of mesh sizes and heights. They are more expensive but can reduce labour costs by being quicker to erect.

Electric fences

In certain circumstances and locations it may be desirable to electrify a game fence. This requires careful planning and design, according to the species it is required to control. Most species, even elephants, can be

taught to respect electric fences, but the emphasis lies on "teaching". Although just a single electrified strand will often function quite effectively, it is recommended that electrification be used as a way of reinforcing the standard 17-strand 2.4m fence.

A conventional electric fence uses three strands, with their positions (height and offset distance) determined by the species which must be controlled. Technical specifications are constantly being improved and the best, most up-to-date advice can be obtained from a number of Botswana-based suppliers. It is not recommended to try to "do-it-yourself", because an important factor is the guarantee and after-sales service which will be provided by a reputable contractor. Another important consideration is human safety; although one function may be to deter poachers, the fence must not be lethal.

Steel cables

DWNP regulations insist that steel cables be incorporated into non-electrified fences which are to contain buffalo, rhino, hippo or elephant. Two 10mm (min.) cables set at 500mm and 1500mm above ground level are adequate.

4.2.2 Holding pens

Holding pens or *bomas* are required for a variety of purposes. Probably the most common use is to hold newly acquired animals after delivery and offloading to allow them a short period to acclimatise to their new environment. Designs are available for a whole range of bomas for different purposes or species, but here only a general purpose, simple and inexpensive facility is described. The most economical structure is probably a permanent frame with removable plastic cladding. This should be stored away from sunlight when not in use.

Necessary criteria:
Siting: away from human activity, buildings, noise, odours, etc; away from perimeter fences; easily accessible.
Construction materials: steel or wooden poles; wire mesh with opaque, plastic capture sheet as cladding; sunken concrete water troughs.
Dimensions: 2 sizes 5 x 5m and 10 x 6m; height 3m.
Shade: natural trees, reeds or shade netting over at least 25% of each pen.
Passages and doors: passages should not exceed 1200mm in width; doors should open against the outer passage wall to funnel animals into pens.
Access: provide feeding hatches to minimise disturbance; water troughs to be filled from outside the pens; inspection "peep" holes.

4.2.3 Loading/offloading ramp

If this is to have a dual function it should be approximately the same width as the average truck door (±1m) and taper to the width of the passage or pen door. The ramp should be ±1,4m high to match most of the trucks and trailers used in Botswana.

Free release ramps

In Botswana many of the ranches are large enough to be suited to the free release of most species. Some ranchers prefer this rather than using holding pens. The siting of such a ramp is crucial. It must be well away (at least 500m) from any fences and preferably fairly close to water.
The ramp must be approximately 1,4m high and preferably 2,5m wide. There should be no raised sides. Provision must be made for offloading from the side and the back of vehicles and trailers. Ideally, the ramp can be made lower by excavating the truck access point, but allowance must be made for the truck/trailer to manœuvre adequately. The last point is often overlooked. The slope of the ramp is not critical, as most species can handle a 1-in-2 slope, but 1-in-3 is ideal, that is to say the length is three times the height.

Kwalata Ranch
Tuli Block

Your prime hunting destination

P.O. Box 3
Gaborone
Botswana
Tel/Fax 5729000
dewet@info.bw

4.2.4 Roads

On most existing ranches the road system is limited to tracks along fences and fairly direct roads to the homestead and other management features such as kraals. The system of roads will not normally have been designed with game ranching in mind. New ranches, on the other hand, can develop a purpose-built road system. Roads have an ecological impact which can be quite significant. It should be possible to design a system for the ranch which combines maximum usefulness with minimum negative impacts.

Generally in conservation areas there are four types of roads, classified as:

- *Management roads:* these are usually specifically routed for use by management staff and avoid, where possible, scenic areas and destinations used by clients or guests. They are often closed, sometimes by physical barriers, to visitors.
- *Game-viewing/Tourist roads:* on ranches where photographic tourism occurs the aim is to provide the guest with the best opportunities of experiencing the scenery and other natural resources on the game ranch. Tourist roads should never include long straight stretches of road but should preferably follow an ecotone. Where possible they should be situated in the more open vegetation types and be about 100m from the border of more dense areas. Tourist roads often link waterholes and traverse as many habitat types as possible.
- *Hunting roads:* these are usually twisting minor tracks that disturb the veld as little as possible. Hunting roads must enable the hunter or cropping team to deliver any hunted or captured game to the skinning or holding facilities with the minimum delay.
- *Firebreaks:* effective firebreaks should be at least 8m wide. They should be planned and built in such a way that they separate the different major eco-types on the ranch. This enables the game rancher to incorporate burning into the habitat management programme. A firebreak can also serve as a tourist road.

Ecological effects of roads

Depending on their construction and location, roads can have various ecological effects on a game ranch. The following are some examples:

- Construction work destroys plants (especially trees) and small animals.
- Poorly planned roads may create erosion problems and lead to habitat deterioration.
- Firebreaks are escape routes for most animals during veld fires.
- Roads are used by game as routes between watering points and grazing areas.
- Mammals such as impala and blue wildebeest sleep on roads during rainy or moonless nights, especially in areas where predators occur.
- Culverts or storm-water drains serve as burrows and dens for warthog, jackals and hyænas.
- Pioneer plants along roads attract hares and steenbok.
- Snakes bask in the sun on roads when the environmental temperature is low.
- Ground-nesting birds breed next to roads.
- Nocturnal animals are blinded by vehicle headlights at night and are run over.
- Quarries near roads provide water for animals out of season, which can lead to over-utilisation of certain areas.
- Roads influence the movement and thus distribution of some nervous species, e.g. sable and eland. This may prevent them accessing important feeding or breeding areas.

Road construction

The highest standard of road that is likely to be required is an all-weather gravel road suitable for game viewing tourist traffic. Recommendations and specifications should be obtained from a suitably qualified engineer. Points to remember are that it should be stable in dry and wet condi-

tions, and that drainage is of paramount importance. Roads on clay soils tend to become muddy and form potholes in wet weather, whereas sandy roads are dusty and form corrugations.

4.2.5 Airstrips

Airstrips can be merely for private use, or they must be registered by the Department of Civil Aviation, Ministry of Works and Transport (DCA) if commercial traffic (including charter flights) is to use them. In the latter case guidelines and regulations should be obtained from the DCA, who will inspect the airstrip and associated facilities before registering it.

Obvious things to bear in mind when planning the construction of an airstrip are the direction of the runway, safe approaches and the position of possibly dangerous obstacles such as koppies, power lines, masts and buildings. Remember also that animals tend to be attracted to airstrips and can be a serious threat to aircraft taking off and landing. It may therefore be necessary to fence the airstrip. The prevailing wind direction in Botswana is from the northeast and most airstrips are therefore orientated between 06 and 09 degrees (M). A minimum safe length of airstrip for light single-engine aircraft is approximately 600m as long as the approaches are unobstructed.

4.3 Provision of water

Water requirements are one of the most important items when planning a game ranch. With evaporation rates consistently several times as high as the annual rainfall, the availability of potable water is often a severe limiting factor in a semi-arid country like Botswana. Nearly all wildlife species at least sometimes require drinking water, though this will vary according to many factors including species, age and condition, as well as with prevailing environmental conditions. Under ranching conditions it must be assumed that all animals require to drink. The amount required by an individual will vary greatly, but it is often quoted that an

animal will consume on average 4 - 5% of its body mass in water every day. This is roughly equivalent to 2.5l per adult impala, 10l for a wildebeest and 14l per average zebra.

On Botswana game ranches most drinking water is artificially provided from boreholes. These need to be carefully sited and designed, in order to complement any natural water points (usually seasonal pans) and cater for the different species' requirements.

4.3.1 Water quality

Poor quality water can lead to serious problems which often remain undetected or are attributed to other factors. These can include poor breeding performance, unthriftyness and poor growth rates, or even outright disease through contamination and poisoning. It is good practice to have all the water sources analysed by a professional laboratory.

In many areas the groundwater is saline, i.e. contains high levels of various salts, usually carbonates and bicarbonates of sodium, magnesium and calcium. These are measured as "total dissolved solids" (tds). Although these may soon make the water unfit for human consumption, it is surprising how much salinity can be tolerated by some species of wildlife. The taste and smell of water, which is æsthetically important to human beings, does not necessarily have the same effect on animals. In extreme cases, e.g. gemsbok and springbok in the Kalahari, wildlife will consume water with very high salt levels up to 10,000 tds, though under most circumstances half of this is normally the upper limit. (For human use the WHO recommends 1,000 tds as the upper limit.)

4.3.2 Location of water points

Several factors play important roles in planning the distribution of water points. Habitat distribution and existing permanent and seasonal natural water sources must be evaluated. The behaviour, territoriality and rang-

ing of the different wildlife species must also be taken into consideration. Most species display a critical water distance and do not normally range further than this distance away from water. For example, impala have a short critical water distance of approximately 2km. On a ranch of 2000ha with sides of 4 and 5km it would be necessary to have at least two water points placed centrally 2km part in order for impala to utilise the whole ranch. Territorial species such as sable would require a water source within each herd's territory, and the numbers of bushbuck would be maximised by having water sources spaced not more than 300m apart in suitable habitat. At the other extreme, wildebeest and zebra quite normally graze up to 5km from a water source and can go much further. Consequently, on large properties permanent water supplies can be spaced as much as 15km apart.

Besides territoriality, several other aspects need to be considered when spacing water points: If only one waterhole is available, animals are forced to concentrate there leading to localised overgrazing, trampling, soil erosion and bush encroachment. Local animal concentrations also facilitate the spread of diseases and parasites. If new animals are released, it is important to have several water sources located around the ranch so that such animals will discover these quickly. Newly released animals often spend considerable time near the perimeter fence and water must be made available there temporarily.

4.3.3 Design and function of water points

When planning water supplies for a game ranch, a range of factors should be taken into consideration. Water sources may be natural, e.g. rivers and rainwater pans, or artificial, e.g. earth dams and troughs or reservoirs. Occasionally the opportunity exists to enhance a natural source through artificial means, e.g. weirs. The requirements for an ideal waterhole might be:

- Sufficient water must be economically exploitable.
- The design must satisfy the drinking preferences of different game species.

- The waterhole must be controllable (can be opened or closed) to encourage game movements.
- The location, relative to that of other waterholes, must be considered to limit overgrazing.
- The waterhole must be permanent and reliable during times of drought.
- Sufficient shade where game can rest after drinking should be avail able in the area around the waterhole.
- The waterhole must be constructed in such a manner that it allows maximum game viewing coupled with minimum disturbance of game movements.
- Waterholes should not be placed on watersheds (high-lying areas between two drainages) or on highly erodible soils.
- Waterholes must be designed in such a way that they provide the minimum cover for predators, but sufficient for shy species, e.g. bushbuck.
- The water quality must be suitable for game.
- The waterhole must appear as natural as possible.

Apart from the above, consideration must be given to the possibility of problems arising from erosion, trampling of vegetation, evaporation, injuries through accidents or fighting and the incidence of diseases.

4.3.4 Borehole pumps

Pumps which are used for game ranching are largely limited to windmill, power-head and borehole turbine pumps and sometimes centrifugal pumps, which are often used when water is pumped from a river to a storage dam. The choice of pump is determined by factors such as the water delivery capacity and depth of the borehole, pump efficiency and economic factors with regard to purchase and maintenance of the pump. The choice of a pump will in each case be dictated by the specific set of requirements. Before a pump is chosen, it is essential that the

supply of water available from the borehole be known. The borehole should preferably be tested during the driest months of the year and the delivery volume of the pump should not exceed two-thirds of the tested water supply.

Windmills - the advantages of windmills are that they are relatively cheap and that their maintenance costs are low. The main disadvantage is that during windless months a water shortage may occur. In certain areas strong gusts of wind can also easily damage windmills. Windmills should preferably be placed out of sight of tourists at waterholes.

Borehole turbine pumps - are centrifugal multi-stage pumps which are constructed as compact units of which the diameter is slightly smaller than that of the borehole. The pump is vertical and is propelled by means of the axial line. Thus the borehole must be straight and vertical.

Electric submersible pumps - are centrifugal multi-stage pumps that are powered by a submerged electrical motor which is cooled by the water in the borehole. The electrical power is supplied by a cable, so the electrical accessories can be installed in a meter-box and thus save the cost of constructing a pump house. Pump houses are unattractive to tourists, but they are essential to protect certain installations against weather damage or some game. Solar-powered pumps are expensive but require less maintenance than windmills and will give a more consistent supply of water.

N.B. Plastic pipes must always be buried to at least 500mm because many animals, from *dassies* to elephants, will damage them, and also sunlight will quite quickly degrade the material.

Buffalo - valuable species such as this are a major boost to profitability

5 WILDLIFE MANAGEMENT

This chapter deals with the establishment and maintenance of healthy wildlife populations. It briefly describes how to monitor those populations and keep accurate records, and finally outlines optional methods of harvesting wildlife for income generation.

5.1 Suitable species for Botswana ranches

Indigenous, exotic and endemic species

Indigenous species are those that occur or have occurred naturally in a particular area and therefore include re-introduced species. The definition of "particular area" may complicate the issue, e.g. red lechwe are indigenous to the Okavango Delta but not to the Kalahari Desert, and *vice versa* with springbok, however, both are indigenous to Botswana. Exotic species are those that do not and never have existed naturally in an area. Endemic species are those that occur naturally in a particular area and nowhere else.

DWNP has not yet developed a national policy on the ranching of exotic species and generally it is not considered a good idea. They do however allow importation of certain exotic species by game ranchers who already have stocks of these species, notably black wildebeest and blesbok. With correct management and proper safeguards ranching exotics may be successful and profitable, e.g. lechwe thrive on some mountainous game ranches in the Eastern Cape, very different and far away from their natural range. For the time being however in this handbook for Botswana we will confine ourselves to those species normally considered indigenous to the country.

Not all species are suitable for every game ranch and careful consideration should be given to which animals will do best with the least management in any given situation. The less suited an animal is to its environment, the more intensive management is needed to keep it and the more expensive this is, the obvious extreme examples being exotic species in zoos.

Very brief descriptions and shorthand notes on the commonly ranched species and their requirements are given below. Some of the breeding characteristics of species occurring in Botswana are given in Table 5.1

5.1.1 Blue Wildebeest *(Connochætes taurinus)*

Preferred habitat:	Open woodland with shade and water
Feeding:	Short grass grazer
LSU equivalent:	0,5
Breeding:	Mating Feb/April; calving Nov/Jan; weaning 8 mths
Growth:	Sexual maturity ♂ 2yrs, ♀ 15 mths; first calf 2yrs
Mass (kg):	Adult live: ♂ 250, ♀ 180; average carcass 82
Trophy:	Minimum age 5yrs, minimum size 23"
Longevity:	18yrs
Status:	Seventh Schedule Part II – game animal

In Botswana they were found throughout the country, but have decreased in the Kalahari areas owing to progressive drying out of the environment, cordon fences curtailing their migrations and human expansion taking over pans in particular. They can exist for long periods without drinking if their food has a high enough moisture content. They are prolific breeders and are most numerous in the Tuli Block, though they can be ranched easily all over the country. They are good meat producers and there is moderate demand for trophies. There is little demand for live sales and prices are generally low because of their ubiquitous

status. However, there is great demand for the "red" tinged type that is frequently seen in the central Tuli Block area, but it is not known if this characteristic will consistently breed true. Nevertheless, some collectors will pay several times the normal value for these animals.
They are asymptomatic carriers of bovine malignant catarrh *(snotsiekte)*, a virus that causes deaths in cattle and there are restrictions on movements in RSA because of this. On the other hand there is some evidence that they can inhibit the breeding of certain ticks.

5.1.2 Eland *(Taurotragus oryx)*

Preferred habitat:	Versatile, semi-arid scrub and most savanna types
Feeding:	Mostly browse (70%), but graze fresh summer grass
LSU equivalent:	1
Breeding:	Mate all year, but calving peak Aug/Sep; weaning 5 mths
Growth:	Sexual maturity ♂ 2yrs, ♀ 18 mths; first calf 3yrs
Mass (kg):	Adult live ♂ 700, ♀ 450; average carcass 360
Trophy:	Minimum age 5yrs, minimum size 34"
Longevity:	♂ 15yrs, ♀ 20yrs
Status;	Seventh Schedule Part I - partially protected

They are very gregarious, often forming very large herds (>300) and develop strong age-group bonds. They are highly mobile and are prodigious jumpers, easily clearing 2m high fences. They breed well and produce very high quality venison. They can be prone to severe tick infestation, especially if confined to small areas and can succumb to heartwater. Trophy demand is high, and their versatility ensures popularity and a consistent demand for live animals. Individuals with more prominent stripes are in greater demand as examples of the subspecies known as Livingstone's eland (*T.o.livingstonii*). These tend to occur mainly in north-eastern Tuli Block. Large bulls will fight and are difficult to translocate.

5.1.3 Gemsbok *(Oryx gazella)*

Preferred habitat:	Open arid grassland, but adapts to bushveld quite well
Feeding:	Mixed feeders, but basically grazers. Dig for succulent roots.
LSU equivalent:	0.45
Breeding:	Breed all year, but calving often correlated with rainfall
Growth:	Sexual maturity 2yrs; first calf 3yrs
Mass (kg):	Adult live: ♂ 240, ♀ 210; average carcass 100
Trophy:	Minimum age 5yrs, minimum size 40"
Longevity:	17yrs
Status:	Seventh Schedule Part II – game animal

An attractive game ranch species with high demand for trophies (females' horns are usually longer) and excellent meat production. It thrives in low rainfall areas, but drinks regularly under ranching conditions. It has been successfully introduced onto "bushveld" ranches in Limpopo Province, RSA and also does well in the Tuli Block and western Central District sandveld. Live animals are in high demand.

Species	Mating	Gestation	Births	Peak	Wean (days)
Blesbok	March - May	210-240	Nov.-Jan.	Nov.-Dec.	120
Buffalo	March - May	330-346	Oct.- April	Jan.- Feb.	150-210
Bushbuck	Whole year	180-200	Whole year	Oct.-Nov.,	180
Bushpig	Whole year	110-120	Oct.- Feb.	-	-
Duiker	Whole year	200-210	Whole year	-	-
Eland	Whole year	271-279	Whole year	Aug.-Oct.	150
Elephant	Nov.- April	660	Sept.- May	Jan.- March	720
Gemsbok	Whole year	261-275	Whole year	Aug.-Sep.	105

Giraffe	Whole year	450-457	Whole year	Feb.- March,	180-240
Hartebeest	Feb.- April	240	Sept.- Feb.	Sept.-Nov.	150-210
Hippo	Whole year	225-257	Whole year	March-June	-
Impala	April-June	194-200	Oct.-Jan.	Dec.-Jan.	120-180
Klipspringer	Whole year	210-215	Whole year	Dec.-Jan.	120-150
Kudu	June-July	260-280	Dec.- May	February	180
Lechwe	Whole year	225(?)	Whole year	Aug.–Dec.	180-210(?)
Mountain reedbuck	Whole year	236-251	Whole year	Apr.- May	-
Oribi	May - June	200-210	Nov.-Jan.	Oct.- Dec.	60
Reedbuck	Whole year	225-240	Whole year	Dec.- May	-
Rhino: Black	Whole year	450	Whole year	Jan., Jun.-Jul	365
Rhino: White	Whole year	480	Whole year	Mar.- Apr.	365
Roan antelope	Whole year	276 287	Whole year	None	180
Sable antelope	May-July	224-240	Jan.- March	Feb.- April	240
Springbok	Whole year	165-180	Whole year	Sep.-Jan.	120
Steenbok	Whole year	168-173	Whole year	Sept.-Oct.,	90
Tsessebe	Jan.- April	235-245	Sept.- Dec.	Oct.-Nov.	-
Warthog	May-July	150-175	Oct.- Dec.	Nov.- Dec.	63
Waterbuck	Whole year	270-280	Whole year	October	276
Wildebeest: Black	March-July	250-260	Nov.-Jan.	Dec.-Jan.	120-150
Wildebeest: Blue	March-May,	250-260	Nov.-Jan.,	Nov.- Dec.	120-180
Zebra	Whole year	360-390	Whole year	Dec.- Feb.	308 - 330

Table 5.1 Reproduction in Botswana wildlife

5.1.4 Impala *(Æpyceros melampus)*

Preferred habitat:	Open woodland, close to water. Frequents ecotones
Feeding:	Mixed feeder
LSU equivalent:	0.15
Breeding:	Rut March/May, lambing Oct/Dec
Growth:	Sexual maturity ♂ 2yrs, ♀ 18m ; first lamb 2yrs
Mass (kg):	Adult live: ♂ 65, ♀ 40; average carcass 25
Trophy:	Minimum age 5yrs, minimum size 20"
Longevity:	14yrs
Status:	Seventh Schedule Part II – game animal

An attractive and gregarious species, with herds commonly comprising a breeding male and up to 100 females (fewer in dry conditions). Other males form bachelor herds of 10 - 30 individuals. They demonstrate conspicuous and noisy behaviour during the rut. They are highly productive (often >90% lambing percentage) and can be harvested at up to 50% per annum in good conditions. Impala are popular game ranch animals because they are adaptable, resilient, breed well and produce high quality venison and popular trophies. They can be destructive to their environment when overpopulated and their numbers need to be strictly controlled.

A trend exists among ranchers to harvest male impala heavily, probably due to the fact that large herds of impala rams are seen outside of the rutting season. It must be considered, however, that the rutting season is a time of intense activity for breeding males, which devote all their energy to mating, fighting other males, and displaying their dominant status. They get little opportunity to feed, and quickly become exhausted. A different individual then usually replaces the breeding male in a female herd every five to seven days, and the exhausted male rejoins the bachelor herd to recuperate. Female impala will cycle only twice

during the rutting season. A breeding herd requires the constant attendance of a capable male, if all females are to be adequately served. From a management perspective, it is therefore imperative to keep sufficiently large bachelor groups to accommodate this mating behaviour.

5.1.5 Kudu *(Tragelaphus strepsiceros)*

Preferred habitat:	Savanna woodland
Feeding:	Browser
LSU equivalent:	0.5
Breeding:	Rut April/June, calving peak Jan/March
Growth:	Sexual maturity 18m, first calf 2,5yrs
Mass (kg):	Adult live: ♂ 250, ♀ 150; average carcass 100
Trophy:	Minimum age 5yrs, minimum size 48"
Longevity:	♂ 9yrs, ♀ 15yrs
Status:	Seventh Schedule Part II – game animal

Greater kudu are widespread throughout most of Botswana. They are mainly found in open woodland, usually avoiding open grassland. They prefer riparian woodland and thickets along drainage lines, broken terrain with sufficient bush, and are often found in rocky areas. They live in small breeding herds, consisting of mature cows with their offspring. These female herds occupy ranges, which can vary in size from 1 up to about 25km^2. Bulls live in bachelor groups for most of the year, and join the breeding herds only during the rutting season. Calves are born at the height of the rainy season, and hide for two to three months before joining the breeding herd.

Greater kudu are diurnal, unless they live in proximity to human activity, when they become nocturnal. They are excellent jumpers and are known to clear 2.5m high fences. They are almost solely browsers, utilising a wide variety of food plants, but generally preferring forbs to woody species. They make some use of open grassland areas during

spring and early summer, when forbs are abundant there. Large-scale losses of kudu during the late dry season are quite common and have been attributed to tannin poisoning. This should be seen rather as a sign of starvation due to overstocking, whether it is aggravated by tannin poisoning or not. The recommended stocking rate for kudu is not more than three individuals per 100ha. In game counts, kudu numbers tend to be underestimated. The most reliable counting technique for greater kudu on a small or medium size game ranch is the known group count in which the individual kudu groups are identified. This is easiest during spring and early summer when their group structure seems to be tighter than during the winter season.

Although greater kudu are attractive animals, they are among the less profitable species, as they are widely available on game ranches and therefore have little live sale value. Nonetheless, they produce very popular meat and desirable trophies.

5.1.6 Ostrich *(Struthio camelus)*

Preferred habitat:	Open grassland and dry shrubland
Feeding:	Grazer mainly,
LSU equivalent:	0.25
Breeding:	Mating July/Sep; hatching Oct/Dec
Growth:	Sexual maturity ♂ 3yrs, ♀ 2,5 yrs; first eggs 3yrs
Mass (kg):	Adult live: ♂ 150, ♀ 110; average carcass 65
Longevity:	30yrs
Status:	Seventh Schedule Part II – game animal

They are of value only for tourism and occasionally as hunting trophies or meat. Wild ostriches have no value to the commercial meat and skin trade. In the Tuli Block heavy predation of the eggs by jackals is a problem.

5.1.7 Red Hartebeest *(Alcelaphus buselaphus)*

Preferred habitat:	Open grassland and dry shrubland
Feeding:	Grazer, rarely browses except under adverse conditions
LSU equivalent:	0.4
Breeding:	Mating March/April; calving Oct/Nov; weaning 7 mths
Growth:	Sexual maturity ♂ 2yrs, ♀ 2,5 yrs; first calf 3yrs
Mass (kg):	Adult live: ♂ 150, ♀ 120; average carcass 65
Trophy:	Minimum age 5yrs, minimum size 17"
Longevity:	15yrs
Status:	Seventh Schedule Part II – game animal

They are normally associated with the Kalahari environment. Although naturally they only occurred in the east in a limited area between Sherwood and Buffels Drift, they are now found on game ranches over a much wider area, where they have adapted to open woodland conditions.

5.1.8 Springbok *(Antidorcas marsupialis)*

Preferred habitat:	Open grassland, pans and dry short scrub.
Feeding:	Mixed feeder
LSU equivalent:	0.08
Breeding:	No strict season, gestation 6m, lambs born mainly in summer, weaned at 4m.
Growth:	Sexual maturity ♂ 18m, ♀ 6m ; first lamb 1yr
Mass (kg):	Adult live ♂ 40, ♀ 35; average carcass 17
Trophy:	Minimum age 3yrs, minimum size 13"
Longevity:	12yrs
Status:	Seventh Schedule Part II – game animal

Kalahari springbok are noticeably larger and heavier than those occurring in other parts of southern Africa. Careful selection is neces-

sary when importing from neighbouring countries. Springbok occur throughout the Kalahari, but have declined dramatically in many areas, mainly because of human expansion. They cannot be successfully ranched in the eastern parts of the country and are particularly prone to heartwater. They also seem to be very vulnerable to predation under ranching conditions, with cheetah in particular causing heavy losses. Even low fences easily contain them.

Meat produced is of a very high quality, with potential for export. Although they can exist without water as long as their food plants contain at least 10% moisture, they will drink when water is available. Drinking increases markedly when temperatures are high and they will consume water which is far more saline than most other species will accept.

5.1.9 Warthog *(Phacochœrus æthiopicus)*

Preferred habitat:	Open grassland, floodplain and woodland
Feeding:	Mainly grazers, but will eat fruit and dig for roots, tubers etc.
LSU equivalent:	0.2
Breeding:	Mating April/May; farrowing Oct/Nov; weaning 5mths
Growth:	Sexual maturity ♂ 2yrs, ♀ 18mths; first litter 2yrs, mean size 3 piglets
Mass (kg):	Adult live: ♂ 100 kg, ♀ 70; average carcass 28
Trophy:	Minimum age 5yrs, minimum size 12"
Longevity:	17yrs
Status:	Seventh Schedule Part II – game animal

Warthogs occur throughout Botswana, even in the drier parts of the Kalahari. They require aardvark burrows for shelter, which they change frequently. Although they are very prolific breeders, up to 50% of young piglets succumb in the first 6 months to predation and adverse weather conditions.

Warthogs are an attractive part of the African wildlife spectrum, and a valuable asset on game ranches. Warthog are useful indicators of over-grazing as they are the first game to visually lose body condition. They are also a well sought-after trophy, particularly by European hunters, and the meat is of high quality. There is little competition between warthogs and grazing antelope. If overstocked, however, warthogs can damage the grass sward due to their digging behaviour. A high number of warthogs may adversely affect the breeding success of terrestrial game birds because they are said to be particularly fond of eggs.

5.1.10 Waterbuck *(Kobus ellipsiprymnus)*

Preferred habitat:	Floodplain, open woodland, long grass/reeds <2km from water
Feeding:	Long grass roughage grazer
LSU equivalent:	0.5
Breeding:	All year round, calving peak Feb/March, weaning 9 mths
Growth:	Sexual maturity ♂ 3yrs, ♀ 2,5 yrs , first calf 3,5 yrs
Mass (kg):	Adult live: ♂ 260, ♀ 180; average carcass 100
Trophy:	Minimum age 6yrs, minimum size 23"
Longevity:	16 yrs
Status:	Sixth Schedule – protected

They are common in many parts of Tuli Block and also occur naturally, but less frequently, in Chobe and Ngamiland. A few have recently been introduced on to game ranches in Orapa, Jwaneng and Ghanzi.

Mature males establish permanent territories rarely exceeding 1km^2, which they defend vigorously and will not leave even in droughts. Female and bachelor herds form loose aggregations which move through these territories. Numbers are easily underestimated because they are cryptic. They are prone to ectoparasites (ticks and lice) especially when

stressed. They have a strong musky smell and carcasses must be skinned carefully to avoid contaminating the flesh. Live sales fetch high prices and limited trophy hunting has recently been allowed.

5.1.11 Zebra *(Equus burchelli)*

Preferred habitat:	Open woodland and grassland, water dependent
Feeding:	Long grass roughage grazer
LSU equivalent:	0.75
Breeding:	All year round, pronounced peak in summer, weaning 11 mths
Growth:	Sexual maturity ♂ 2 yrs, ♀ 2 yrs , first foal 3-4 yrs
Mass (kg):	Adult live: ♂ 320, ♀ 300; average carcass 170
Longevity:	22 yrs
Status:	Seventh Schedule part II – game animal

Good populations of zebra have been established on several game ranches from wild stock, especially in Ghanzi.

Zebra are typical of the savanna plains, preferring open woodland or medium to tall grassland in the proximity of water. They are bulk feeders, utilising a variety of grasses, which are not used by the more selective grazers. In the process of using stands of tall grass, such areas are trampled down. Therefore, zebra have the added positive effect of opening up such grasslands for other game. They are partial to burnt areas. Zebra live in close family units, which consist of a dominant male with two to three (maximum of six) females. They are not territorial, but the stallion defends his harem against other males. The family unit is kept intact even when numerous zebra congregate, forming large herds. Zebra mares are usually good mothers with close bonds with the foal. Sub-adults leave the family unit at the age of one or two years. The females join a new stallion, and the young males form bachelor groups until they are old enough to breed and acquire their own females.

Zebra are a valuable ecological asset for most game ranches, which tend to be overstocked with selective grazers. Their tourist potential must also be considered, as for many overseas visitors, zebra are one of the most attractive African game animals. The zebra is often believed to be a prolific breeder, and that its numbers on a game ranch will increase rapidly. On the contrary, they breed comparatively slowly as mares give birth to their first foal at an age of three to four years only. The reputation of rapid breeding might originate from the fact that zebra are such conspicuous animals, and that they move quickly from one area to another, hence their numbers are often overestimated. Too drastic a reduction could result in a long recovery period before the population builds up again.

There is a demand from international hunters for trophies from male zebra. There is no specific trophy requirement for zebra skins although the rancher should watch for older stallions losing the hair on their necks, and thus producing an unacceptable trophy. Darker skins, i.e. with broader black stripes, are considered by some hunters to be a superior trophy. Sexing a zebra in the field can be difficult. Although not a hard and fast rule, a mature female zebra can be recognised by her potbelly while a male zebra has a flat belly, and a thicker neck and wider rump than the female. Also, the black area between the buttocks is broad in females and narrow in males. When running off, it is usually the male zebra that is last, and which stops to look back at the cause of the disturbance. Zebra venison is difficult to market, as many people do not eat zebra meat for cultural reasons. Currently, good quality skins are worth more than live animals.

A subspecies known as Chapman's zebra *(E.b.chapmani)* is recognised mainly from Zimbabwe and there is an added demand for this. The main characteristic is that the stripes continue down the legs as far as the hooves. Many Botswana zebras display these markings too, especially in the populations in the Makgadikgadi and northern Tuli areas.

5.2 Establishment of wildlife populations

Having decided on the spectrum of wildlife for a game ranch and the initial required stocking rates for the desired species (see Ch.3), methods of acquiring the animals must be explored. Live game can normally be sourced in a variety of ways:

5.2.1 Live game auctions

These are held frequently at various centres throughout RSA and Namibia and are advertised in the farming press and in wildlife and hunting magazines. The animals can be viewed in sales pens and having made a successful bid, arrangements for transport to the ranch will be required. This is often available through the auction proprietors.

Disadvantages:

- payment is at the fall of the hammer;
- prices vary widely and tend to be high;
- animals are handled excessively leading to stress;
- auction pens can harbour infection and parasites;

Advantages:

- animals can be viewed and evaluated at the time of purchase.

5.2.2 Catalogue auctions

These are often held in conjunction with live auctions, though not always. Animals are sold subject to payment of a deposit, for delivery at some specified date in the future. The balance is payable on delivery. Prices tend to be slightly lower than at live auctions.

Disadvantages:

- deposit may be tied up for a considerable time before delivery;
- animals are not seen until delivered.

Advantages:

- less stress on animals;
- prices tend to be lower;
- full payment is only made after satisfactory delivery.

5.2.3 Directly from established game ranches

In this case the price is negotiated between the seller and the buyer. One or the other party (usually the seller) will then engage a reputable game capture company to catch and deliver the animals.

Disadvantages:

- animals are usually not seen until captured;
- logistical arrangements to be made (permits etc);

Advantages:

- lower prices due to exclusion of "middlemen".

5.2.4 Through game dealers or game capture companies

This is probably the most common method of acquiring game in Botswana. Dealers will source the required animals and quote a price which will depend on the price paid to the farm of origin, the capture cost and the cost of transport to the destination. In Botswana the transport costs are often the most significant factor. Prices will depend on loads because it obviously costs the same to transport one animal as it does a full truckload.

Disadvantages:

- possible higher prices due to dealer's commission;
- animals are usually not seen until delivered;

Advantages:

- all logistics are taken care of.

5.3 Group composition

The numbers, ages and sexes of groups of introduced animals is crucial to the success or otherwise of establishing viable and therefore exploitable populations on a game ranch. When introducing a new "seed" population, the number and structure of the group influences the subsequent growth rate and therefore the level of income which can be generated until the population reaches its desired level. The following simple hypothetical example illustrates this.

Impala are introduced as two herds: A: 3 adult females and one ram; B: 8 adult females and 2 rams. The following assumptions are made: (1) the lambing percentage among the mature females is 80 %; (2) lambs are born at a sex ratio of 1: 1; (3) females give birth for the first time at the age of two years; and (4) the natural mortality rates do not differ between the two populations. The population growth curves for populations A and B should look as in Fig 5.2

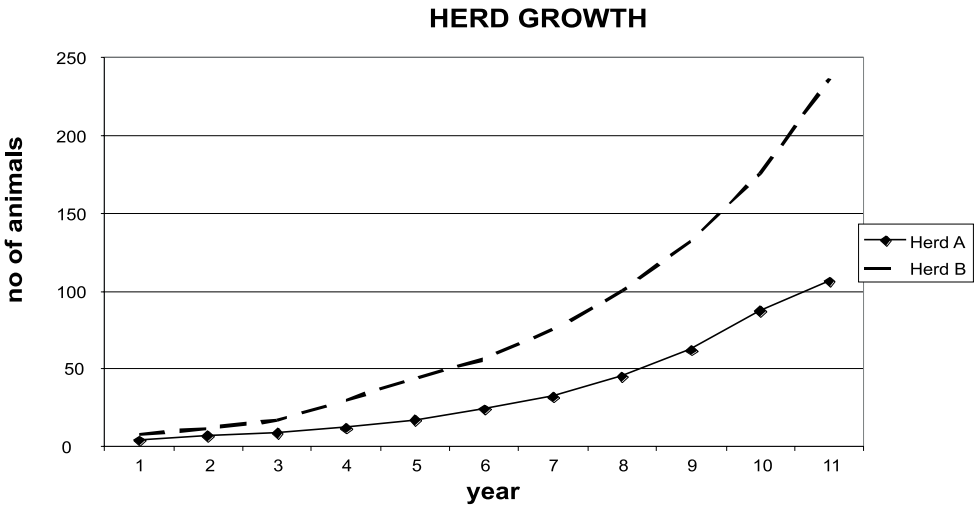


Fig 5.2 Hypothetical Population Growth

Herd A grows considerably slower than herd B. After 10 years, herd A has reached a size of 106 and herd B of 236 individuals. If one impala were valued at US$ 100, the initial additional investment of US$ 600 in herd B has resulted in an additional value in live impala of US$ 13 000 after this 10-year period.

It is also important to consider that a limited harvesting of surplus males and old females can take place much earlier in herd B than in A, i.e. once the population has entered the upswing part of the growth curve and

while it is still growing to the desired level. That means that investing more in the establishment phase by introducing a larger initial herd leads to a faster financial return than when few animals are bought. It is therefore advisable to acquire more individuals of a few species than few individuals of many species.
The number of reproducing females in the initial herd obviously has the greatest influence on the subsequent growth of the population. Female sub-adults should also be introduced, to avoid a generation gap in the population structure.

Concerning the males, at least two, but preferably three mature males should be introduced. This reduces the risk of inbreeding and the risk of losing one or two generations of offspring in case the only male dies or does not mate. Besides, the stimulation of a competing male is necessary in some species to induce breeding. Some sub-adult males should be introduced, so that male replacements are available at all times. Surplus males can then be harvested as trophies while the population is still growing.

For herd game, the following population composition can be taken as a general guide for introductions:

2-3 adult males /4-6 adult females / 3-4 sub-adults (1: 1) / 4-6 juveniles (1:1)

If a larger herd can be acquired, the ratio should lean towards more adult and immature females.

In practice, concessions will often have to be made. Mass capture of game cannot be too selective and the buyer must understand that it may be impossible to combine a herd of the exact structure that he

has ordered. Acceptable limits should be agreed upon before game is caught and translocated.

5.3.1 Sex ratio

The ratio of mature males to mature females can be manipulated through management. A greater proportion of females results in a higher lambing/calving percentage for the overall population. When the objective of a ranch is to produce animals for live sales or for venison, the greatest proportion of females per male allowable for a species will yield the most profitable result. To maintain a sex ratio with a high proportion of females, a high number of male offspring must be removed annually from the population before they mature. Immature males are difficult to sell live as the demand is biased towards female breeding stock, and a proportion of these young males will have to be culled for venison.

When the trophy value of a species is high, it is economically wasteful to cull males prior to maturity. When trophy hunting is exercised on a ranch, trophy fees usually constitute the bulk of this ranch's income. A sex ratio of one mature male to one mature female is then optimal for economic reasons. In natural systems, this is the commonly found sex ratio for game. Excessive conflicts between males in herd game species are avoided by forming bachelor herds, whose members respect the established dominant males and keep out of their territories, or by displaying submissive behaviour. The dominant males are occasionally challenged by potential successors and are replaced when they lose strength. This contest is natural and even necessary to stimulate breeding. Problems can arise on small or overstocked ranches when the space requirements of the bachelor herds are not met and these are forced to stay in or close to the established territories. To avoid this situation, one must consider the average territory/range size, herd size and social density of each game species when planning the stocking programme and leave sufficient space for the bachelor groups.

5.4 Population monitoring

Except on very small intensively managed properties it is not necessary to know the exact numbers of game. In fact, it is almost impossible to count a variety of species accurately. The most important thing is to understand and quantify any trends in population changes. This means that censuses should aim at precision (reliable repeatability at comparable accuracy) rather than absolute accuracy. Combining this information with detection of changes in the habitats through assessment of veld condition is all that is needed to manage the ranch successfully.

5.4.1 General monitoring

Animals should be monitored on a regular basis throughout the year for a variety of reasons. It is advisable to keep familiar with the animals to detect problems at an early stage and rectify these where intervention is required. Sick and injured animals can then be removed before they have a negative impact on other game or on the tourist enterprise. Some benefit from such animals can be salvaged before they die, or they can be submitted for disease investigation. When animals are required for hunting or game viewing, a person who is familiar with the whereabouts of the animals is invaluable. General game monitoring should routinely be conducted throughout the year on at least 2 to 3 days per week. In doing so, staff drive or walk different sections of the ranch in such a way that the entire ranch is covered every week. Relevant observations should be recorded on a field form using a map overlaid with a grid for location references. Animal observations that should be recorded include the game species, number of individuals, their age and sex classes where possible, and their location. Other records include the species, sex and approximate age of carcasses found, sick or injured animals seen, signs of poor body condition, births, fights, unusual behaviour, attempts to escape, drying up of water points, finding of snares, or damage to the fence. Whenever animals are taken off, be it for trophy, venison or live sale, the species, age, sex and body or carcass weight and trophy size

where applicable must be recorded. A staff member who is well experienced in this routine, will easily organise and perform the annual census. In particular known group counts will entirely depend on him, as well as other related duties such as accompanying hunters.

Annual census

The primary objective of a game count is to estimate the number of animals in a given area. The main problem is to obtain a count which will form a reliable foundation for population management. Game counts can comprise total counts, where the objective is to count all the animals in a given area, or they can take place on a sample basis, where deductions about the entire area can be made from counts conducted on a smaller area. The problem is aggravated by the fact that animals are usually not evenly distributed, but rather tend to congregate in patches in preferred sections of the habitat, i.e. they are "clumped".

Timing: The ideal time for an annual census for each species is after its calving/lambing season, as this is the time of maximum animal numbers. For many seasonal breeders this time will be during or at the end of the rains. Unfortunately, visibility is then at its lowest and it is impossible to achieve accurate or precise counts. Visibility is best during the months of October to December. Although many of the trees are already in leaf at that time, the grasses are dry and usually somewhat flattened or only just sprouting. It is recommended that most counts be conducted in November or early December as at this time many of the antelope species have already given birth. Births that will be missed at this time are those of waterbuck, zebra, kudu, buffalo, and wildebeest, who give birth mainly from December to March. Some game species have protracted birth seasons and for these, timing of the count is not crucial provided it is performed at a consistent time every year.

Technique: There is no single comprehensive counting technique which

is suitable for all types of game and habitat. Knowledge of the animals and their habitat requirements are essential before any game count can be attempted. Game in treeless regions or open bush veld areas can, for example, easily be counted by means of aerial counts. In dense bush veld or woodland a combination of methods produces better results.

5.4.2 Known group count

Gregarious species whose numbers are low can be most accurately estimated through becoming familiar with their groups and home ranges. This method is invaluable for private ranches as it is easy to conduct, is accurate if conducted with care, requires a minimum of personnel (is best done by the persons patrolling the ranch throughout the year) and costs are minimal. It can be carried out in all types of habitat, from open grassland, woodland to mountainous terrain. This type of count should be performed on all game species that can possibly be counted this way. It involves patient observation of those animals that live in identifiable groups or as identifiable individuals. Groups are quietly observed when they are encountered in suitably open habitat. If animals become too nervous, the count is aborted and repeated on another occasion. It is at times helpful to have a second person to drive the respective animal group gently and slowly towards the hidden observer. Eland tend to split up in smaller units and re-unite again into one herd, and care must be taken to count them all. Zebra live in close-knit family units that sometimes aggregate into a larger herd. When this aggregation is resting, the family units are more easily identified and evaluated as they will tend to graze in clear groupings. The location of each group should be recorded to avoid double counting. For the location records, a map of the ranch is required that is overlaid with a grid pattern of approximately one hectare per grid square. Each grid is defined by vertical and horizontal co-ordinates. This can easily be hand-drawn over an existing map. All members of an encountered group are classified into their respective age-sex categories and recorded on an appropriate record sheet. The following

age-sex categories can be used:

- Adult male: after reaching sexual maturity;
- Adult female: after giving first birth;
- Sub-adult male: all males between 1 year old and sexual maturity.
- Sub-adult female: all females between 1 year old and first birth. (For most species this generation is presented by the last year's juveniles. For some species, which mature slowly, this category includes the juveniles of the last two years, namely zebra, tsessebe, eland, sable antelope, roan antelope and waterbuck; for buffalo three to four generations of juveniles comprise this sub-adult male group.)
- Juveniles: all calves/lambs/foals/piglets under 1 year of age.

The known group counts should be conducted every year over a two to four week period during November/December. At this time the count includes all those seasonal breeders that have given birth by then and all possible protracted breeders. Other seasonal breeders are counted once their young are born (e.g. zebra, buffalo, wildebeest) or once the young have left their hiding places and accompany their mothers (e.g. waterbuck, kudu). This will mostly be by March.

5.4.3 Road strip count

Some game cannot be identified easily as individuals live solitarily or are difficult to encounter and these are best counted in a road strip count. It is also a more appropriate technique for large wildlife areas, where it becomes more difficult to know individual herds. A road strip count requires open habitat with good visibility or an appropriately tight network of roads in denser vegetation. All areas should be visible from roads. In such circumstances, results of a road strip count represent an estimate of the total game numbers. If the road network is not as dense, the rancher must determine the width of the strip along the roads in which game can be counted prior to the count. The area of these strips is

then calculated. The number of game observed in these strips represents a fraction of the total number. The total number can be extrapolated when the entire area of the ranch is known. This method assumes that game is evenly distributed. To improve the precision of this count, it is advisable to consider the various habitat types separately, as game will show preferences for one or the other. Results of road strip counts are often underestimates of the actual game numbers, particularly for the elusive and small species.

Road strip counts are best conducted during November or December when visibility is highest. It should be repeated three times during a 1-week period. The entire ranch or representative parts thereof are covered on one day by road and observations are made from a vehicle. At least two observers and a driver each with binoculars and familiar with identifying and sexing the animals must systematically drive a set route at slow speed (±20km/h). The same procedure and route should be followed every year. Animal numbers and respective age/sex categories for all animals not included in the known group count are recorded on appropriate field forms. Additionally, locations of animals observed must be marked on a map while counting as an attempt to prevent double counting of individuals or groups. Particular attention must be paid to this issue, as double counting is a common error. The less the variety of species to be counted, the easier it is to conduct the census and the more reliable it becomes. If counts vary between counting days, the highest count per species is taken as a final figure.

Duiker, bushbuck and bushpigs are likely to be undercounted in this method due to their secretive behaviour. The accuracy of their counts can be improved by plotting all relevant observations over a 2-month period on a map. This will visualise the existing territories or home ranges. Animal numbers and population structures can then be calculated from these.

5.4.4 Drive count

In a drive count, animals are driven by a line of beaters and recorded by these and additional observers as animals are passing through their respective lines. It can be carried out in most habitat types and will yield accurate results if conducted professionally. It requires good co-ordination in a well trained, knowledgeable and highly disciplined team. This method is only advisable if a professional team can be hired for the occasion and the known group counts have been unsuccessful. To attempt a drive count with a team of unskilled farm workers will probably be disruptive to the animals and result in chaos.

5.4.5 Aerial count

An aerial count is costly, but it is quick and can yield reliable results if the entire ranch area is flown systematically and visibility is optimal. An experienced helicopter pilot covers approximately 1,000 - 2,000ha per flying hour in most Botswana areas. In wooded habitat, animal numbers are invariably underestimated. Helicopter counts typically give a total number per species but not a breakdown of the population structure. Species where a known group count can be applied, should not be included in an aerial count in order to improve the precision of counting other species and save on flying time. Counts using fixed-wing aircraft provide a suitable technique for large ranches (> 20,000 hectares). They are more economical, but rather than attempting a total count, a stratified sample count is normally used. The precision of such counts depends on the habitat, the visibility of the game, the accuracy with which the pilot maintains speed, flying height and direction, the choice of the strip width in which game is counted, the time of day, and the experience of the crew. At best they are crude tools and need painstaking skill and care to generate precise results. Only experienced professionals should undertake aerial censuses.

5.5 Population parameters

These are simply a set of values expressed as percentages of the total population of a species. They are usually called "rates", e.g. birth rate, mortality rate, etc, because they refer to a time period (normally one year). They are used in various simple calculations for management purposes.

Annual birth rate: this is the number of young born to a population in a year, expressed as a percentage, e.g. if 40 impala lambs are born from a total population of 160 impala, the birth rate is 40/160 x 100 = 25%.

Annual mortality rate: this is the number of naturally occurring deaths in a population in a year, expressed as a percentage. It should include any unaccounted disappearances. For example, in a population of 160 impala there might be 8 deaths, so the mortality rate would be 8/160 x 100 = 5%.

Annual harvesting rate: this is the number of animals removed from the total population in one year expressed as a percentage, e.g. if in a population of 160 impala 32 were killed or sold the harvesting rate would be 32/160 x 100 = 20%.

Annual growth rate: this is the increase in the total size of the population in one year expressed as a percentage. It should include any animals harvested (killed or live sales), e.g. in an impala population if there were 160 at the end of 2003 and there would have been 192 at the end of 2004, the growth rate would be (192-160)/160 x 100 = 20%. However, if 30 had been harvested the actual population at the end of 2004 would be 162, so the correct equation to use is
([162 + 30] – 160)/160 x100 = 20%.

N.B. In a well managed game ranch the calculated annual harvesting rate might approximate the annual growth rate; however, it might be desirable to manipulate the population in favour of adult females if

maximum annual growth rates are desired for venison production, but this might not be appropriate if trophy hunting or photo-tourism is the main purpose of the ranch.

5.6 Harvesting wildlife

There are a number of options for management of a game ranch and these have been described in Ch.2. For the purposes of this section it is will assumed that, as on most game ranches, a sustainable harvest over a long time period is one of the management aims.

Basic parameters describing population dynamics have been described above and the concept of sustainable yield was discussed in Ch.3. The annual harvesting rate can be calculated or estimated from available census figures and other data, or quite often through careful trial and error. In practice a combination of both methods is probably most useful – adjusting offtakes according to observed results. The question is: to what number should a population be reduced to achieve the desired objective, and what percentage offtake (harvest or quota) does this imply? As a starting point, a population that is in equilibrium can often quite safely be reduced by 25 - 30 % initially, and even 50% might be possible in some cases. However, a conservative approach is recommended and it is crucially important to monitor the effects of any harvesting to avoid rapid changes which may lead to a catastrophic decline in any population.

Harvesting must always be a flexible option. Environmental, economic or other conditions may change abruptly and will impose different management choices on the ranch. If, for example, a series of drought years occurs there may be increased natural mortality and the harvest should be reduced, or conversely, it may be necessary to reduce numbers quickly to avoid excessive mortality. Each year the situation requires careful monitoring and adjustments made.

5.6.1 Harvesting of growing populations

Animal populations that have not yet reached their maximum number (equilibrium) can sustain a limited harvest and it would be wasteful not to do so. In this case the minimum population structure for this species should be determined. No offtake of females should be considered until the number of mature females exceeds the calculated minimum number. Males, once they produce a quality trophy, should be harvested, as their trophy quality may decline thereafter, always provided that sufficient males remain for breeding purposes.

5.6.2 Timing of harvest

Ideally the majority of surplus animals should be harvested before or at the beginning of the dry season. This way, adequate food reserves are available to sustain the remaining animals through the dry months until the start of the next growing season. The timing though depends on other factors as well. Most trophy hunts take place from May to September. Hunting in the concession areas is restricted to the hunting season and as many hunters coming to Botswana combine hunts in concessions with hunting on private ranches, the latter are still affected by the official hunting season. Also, this is the best time for capture operations as it is not too hot or humid, visibility is good and neither the birth nor the mating seasons for most species are disrupted. This leaves the rancher only with flexibility regarding those animals that are culled for venison. It is tempting to wait with culling exercises until the capture operations are over (there might always be a last minute buyer). However, it is a poor policy regarding the vegetation and the available food supply for the remaining game, as many surplus animals have to be carried through the dry months. A game rancher is better advised to take off surplus animals that are unlikely to be sold live as early as possible. This not only favours the remaining game but animals culled soon after the rainy season will be in optimal body condition and will yield higher carcass weights than at the end of the dry period.

5.6.3 Theoretical example of harvesting impala

Table 5.3 illustrates a theoretical population of 400 impala, typically made up of the various proportions of each age and sex category. If we assume the population is in equilibrium and we can harvest 25%, leaving a minimum population of 300 which should rebound to equilibrium of 400 during the next year, then the theoretical harvest should be approximately as indicated.

	Total	Adult ♂	Adult ♀	Sub-adult ♂	Sub-adult ♀	Juvenile
Original	400	58	160	45	50	87
Minimum	300	35	115	35	35	80
Harvest	100	23	45	10	15	7

Table 5.3 Theoretical harvest from impala herd

The options for harvesting methods are discussed below. In this case it might be decided to offer the 23 adult males as hunting trophies, shoot 12 adult females for monthly rations and offer the remaining 65 animals as a live sale package of 33 females with 7 juveniles and 25 sub-adults.

5.6.4 Optional methods of harvesting

Removing animals from a wildlife population on a ranch can be done in a variety of ways. Sport (trophy) and recreational hunting, cropping for venison and/or other products, and live sales are the main options. Smaller scale hunting for rations may also be significant.

Safari hunting

This is especially important in the Botswana context. In Botswana the hunting industry is heavily skewed towards very expensive, traditional safaris in large exclusive areas. Safari companies rely heavily on "big five" species to attract clients and then sell less glamorous species in a package. Recent quotas indicating a decline in availability of some species provide an opportunity for game ranching to develop to meet this demand. At present many game ranches offer mainly plains game to supplement the experience of foreign clients of safari companies. A growing number however are competing by carrying out their own marketing and successfully offering a more complete hunting package. In RSA, for example, trophy hunting takes place almost exclusively on private game ranches and caters for more hunts than the rest of Africa combined.

The high unit prices paid for trophy animals will always be an important source of income for game ranchers, irrespective of other forms of utilisation. Only a certain number of animals are really of outstanding trophy quality. As a general guideline, researchers regard 5 % of the animals in a natural population as being of trophy quality, and this is influenced by factors such as the species of animal, whether both sexes have horns or not, and nutritional quality. In practice every game rancher must determine his own percentages during an annual game count because there is no reliable formula for calculating the numbers of trophy animals.

A great deal of research has been done to try to correlate trophy size with age in the various species. It has not proved completely reliable, but the following can be used as an indication of when some species can be expected to become trophy animals: buffalo 5yrs, impala 4,5yrs, sable 6,5yrs, springbok 2,5yrs.

Management for trophy production:
Animal numbers must be limited to the level at which competition for resources between individuals is minimised and each animal is capable of reaching its genetic potential in terms of growth and trophy production. Heavily stocked ranches will not yield top quality trophies. The ranch should therefore be stocked well below the ecological capacity of the vegetation. Sex ratios must be maintained to produce the maximum number of males of trophy-bearing age. This requires the sex ratio to be maintained at approximate parity and a balanced removal of young and old females to compensate for the increased removal of mature males.

Ranch requirements: At present many hunters visit game ranches in Botswana only after having hunted in concession areas in remote parts of the country. A short period of two to three days is often allocated in which to hunt game that they were unable to obtain elsewhere. Many hunters are looking for a wide variety of game on the game ranches. Their time is limited and the trophies must be readily accessible. This requires a good network of simple roads that are æsthetically planned to suit the vegetation layout. Roads should therefore not be in a rigid grid pattern. A game scout who knows the whereabouts of the available trophy animals at the time of the hunt is invaluable to the hunter who has limited time. Visiting hunters require accommodation, which ideally should be provided on the ranch on which they hunt. Foreign trophy hunters pay a high price for their hunting trip and generally expect a good standard of accommodation. The rancher can increase his profits through supplying comfortable facilities to accommodate small hunting parties, with quality catering provided. Increasing numbers of hunters do come to Botswana to hunt exclusively on private game ranches without visiting concession areas. With a growing private game industry offering a wider game spectrum and good quality trophies this trend will hopefully continue. Special attention must also be given to the general

atmosphere created on a ranch, the ethical aspects of hunting, and the quality of the trophy handling process.

Recreational hunting

This is a neglected but growing sector of game ranching in Botswana. It is the logical successor to citizen and resident hunting which is now all but defunct in the controlled hunting areas. Increasing affluence and urbanisation of the population ensures that there are growing numbers of citizens and residents who are seeking a relatively short, inexpensive and convenient hunting experience. Recreational hunters usually want a combination of trophy, meat and enjoyable atmosphere from their hunt. Trophy quality is not of paramount importance and they will often take non-trophy males or surplus females. In Namibia these clients account for 30% of hunting on game ranches and in RSA the figure is over 60%, while at present in Botswana it is below 10%.

Recreational hunters will expect to be more self-reliant than safari hunters and will not demand such high standards of accommodation, etc.

Venison production

There are basically five ways of removing animals for meat production:

Conventional hunting: This method can be applied on foot, from a vehicle or at a waterhole for a variety of game. Advantages of this method are that it causes little disturbance, game do not run much and consequently they yield a high quality of venison. Selection can also take place with regard to sex and age. However, this method is of practical value only where game has to be shot on a small scale.

It may be unethical to shoot game at waterholes, but it is effective for timid animals such as kudu and bushbuck, for game which occur in small groups such as warthog, or in areas of impenetrable bush where walking is virtually impossible. On game ranches where hiking trails are

offered, game should preferably be shot from vehicles, while on ranches that concentrate primarily on game drives, hunting should take place on foot.

Shooting at night: The animals are dazzled with a strong light and shot from vehicles at a distance of approximately 25m on dark moonless nights. Light-calibre rifles with telescopes are used to ensure minimal meat loss from bullet wounds. Shot placement is important since shots in the neck, shoulder and buttocks can lose up to 3, 20 and 50 % of carcass value respectively. The advantages of night-shooting are that more head and neck shots can be fired; heat, wind and flies are limited or absent at night; lower night temperatures allow better meat quality; and night-shooting does not disrupt other game as much as day-shooting. A disadvantage of night shooting is that it is more difficult to distinguish the sexes of game where both sexes have horns.

Using a passive boma: Similar in some ways to shooting at a waterhole. The great advantage of this is that animals can be killed when convenient and when optimum conditions occur. The animals are calm and sex differentiation is easy. It is only feasible for small numbers of animals.

Shooting from a helicopter: Animals are normally shot in the head with a twelve-bore shotgun from a helicopter. A ground team follows in a vehicle to collect the dead animals. This method is applied by commercial game harvesting teams, since it requires a high capital investment and professional expertise.

The advantages of this method are that wounded animals are easily traced, the animals are harvested more quickly, better selection can take place from the helicopter, and a quick estimate of the game population can be made. The disadvantages of the method are that it is expensive, it results in a poorer quality of meat on account of animals having been

chased, and it is difficult to carry out in woodland areas.

Capture boma and helicopter: This method is not often applied in practice as other methods are usually more economical. The exception is when the boma and helicopter are already available because live capture is taking place. Game is driven into a plastic capture pen with the assistance of a helicopter and then shot with a light-calibre rifle from the ground. This has great practical advantages for bushveld areas since large numbers of animals can be harvested in a short time, the animals can be harvested in areas which are accessible to processing and refrigeration vehicles, and no wounded animals are left behind.

Management for venison production:

To manage a ranch primarily for venison production, the ranch should be stocked with species that are well adapted to the local conditions, have high reproductive rates, and which yield a good quality venison. The selected game must be gregarious without having behavioural limitations on their stocking rate. Carcasses of smaller game such as impala are easier to handle and market than larger carcasses. Management is simplified when a limited variety of game is stocked. Species are selected to minimise competition and ensure that all major habitats are utilised adequately. Ranch size and diversity of habitat are less crucial when considering venison production. Depending on the location of the ranch suitable species include impala, springbok, eland, gemsbok, kudu and blue wildebeest. Limited local markets exist for venison, but efforts are under way to locate export possibilities.

A combination of beef and venison production can be ecologically sound, particularly so when mixed-feeders and browsers are combined with cattle. Other forms of utilisation of the game should be included if possible to maximise profit.

Population size and sex ratios are maintained at levels that yield the maximum growth rate for each species. The minimum ratio of mature males to females is kept that will ensure reproductive success and highest calving/lambing rates. This system aims at a maximum number of producing females. The population is kept well below the ecological capacity. This will ensure that the population growth occurs within the exponential part of the growth curve. Culling should preferably be done by professional teams. The frequency of culling will depend upon the market demand. Carcasses should be processed and cooled on the game ranch, using either permanent or mobile facilities.

Ranch requirements

Minimal infrastructure is required other than sufficient water points to ensure even utilisation of the ranch area and access tracks for light vehicles to all parts of the ranch. If no mobile culling unit is available, permanent butchering facilities including cool-rooms complying with national or international health standards must be established on the ranch or nearby.

Live sales

Commercial game capture is a highly specialised undertaking which requires large capital expenditure for equipment and expensive operating costs for the hire of helicopters, specially designed transport, drugs, etc. Capture operations are usually described as using either mechanical or pharmacological methods. In general the routine capture of most plains game is by mechanical means, using either nets or plastic bomas; drug immobilisation is normally reserved for large, rare or very expensive individual animals such as rhino and giraffe.

The terrain is an important criterion for deciding on an appropriate capture method. Bush is needed to hide nets and bomas, but if it is too dense or there are high trees the use of a helicopter may not be possible.

Stress and "overstraining": These two terms are used very often in connection with the capture and translocation of wild animals. They are frequently confused; be aware that they are different things. Stress is a complex physiological condition that almost defies definition. It occurs owing to a wide range of causes including poor nutrition, exposure, inadequate space, injury, separation anxiety and overexertion. Any combination of harmful circumstances will cause stress. If the cumulative effects of these become overwhelming the animal will succumb and die. "Overstraining disease" (capture myopathy), on the other hand, is a specific condition which occurs owing to excessive forced exercise. This causes a very high build up of lactic acid leading to mainly irreversible changes in muscles. This damage is often serious enough to cause death, even up to a few weeks later. The two conditions are not related, but they often occur together. Different individuals, as in people, demonstrate varying degrees of tolerance to stress, but it must be kept to a minimum by performing capture operations as efficiently as possible and under optimum conditions. Certain species are especially prone to capture myopathy e.g. tsessebe and zebra. Remember that animals are not naturally fit athletes, working animals such as racehorses require intensive training to become fit.

5.6.5 Capture methods

A number of methods are available to take off live animals:

- Plastic boma and helicopter:
  This is the most common method used for plains game in Botswana. Large numbers can be caught efficiently in a short time. Suitable species include blue wildebeest, eland, gemsbok, impala, kudu, ostrich, red hartebeest, waterbuck and zebra. The most important criterion is a suitable boma site with good bush cover for camouflage.

- Nets:
  Using nets is the second most common way to catch multiple numbers of game. The nets can be tightly fixed to trees and poles in any number of trap designs, including replicating plastic bomas where the terrain or vegetation makes it difficult to hide the latter. They are also frequently used as "drop nets", when they are attached only loosely and designed to fall and entangle the animal. The most critical factor when using nets is to have enough competent staff to handle the animals and extricate them efficiently. It is also necessary to be aware of the normal flight paths of the animals being chased in order to position the nets correctly. The most suitable species include animals that live in open plains, such as black wildebeest and springbok, or those inhabiting dense bush like bushbuck.

- Passive capture:
  This can be done by means of a permanent capture boma situated around a well-frequented feature such as a waterhole. The boma is left open and animals gradually get used to entering and leaving it at will. They can also be enticed there by salt or concentrate feeds. When the required animals are inside the entrance is closed quickly, trapping them. There should then be a system of herding them into holding pens and/or to a loading ramp. A similar technique uses either a "drop" boma or "pop-up" boma which is made of plastic capture sheeting that can be triggered remotely to trap animals at salt licks, water holes etc.
  The advantages of these methods are that they cause minimal stress, but their drawback is that only small groups of animals are usually caught and the group composition is often unsuitable.

- Chemical immobilisation:
  This is nearly always by means of darting, usually from a helicopter.

A number of different drugs are available for this use – some of them, like M99, are extremely dangerous and addictive and tightly controlled by law. Botswana regulations also require that darting be done only by a registered veterinarian. These techniques are expensive and are normally only used to capture valuable individual animals. In practical terms they can be applied to almost all species above the size of an impala.

- Net gun:
  This can be used to capture a wide range of species. It is normally fired from a helicopter and netted animals must be recovered quickly by a competent ground team. It is a very dangerous technique and should be left to experienced professionals.

5.6.6 Loading and transport

Most casualties occur during this phase of game translocation. It is an extremely stressful experience for captured animals and may be quite prolonged (some deliveries take in excess of 24 hours). It is essential that suitably constructed trucks and trailers are used for game. Cattle trucks are not adequate for most species. In some species, e.g. red hartebeest and springbok, casualties are markedly reduced by the use of tranquilisers; others must be transported in complete family groups, e.g. zebra, or in individual compartments or crates, e.g. kudu bulls. In the interests of animal welfare, as well as economics it is advisable to use properly equipped and experienced professional teams to move animals.

Red hartebeest entering crush section of capture boma

6 Veterinary Aspects

As with any form of livestock ranching or animal husbandry, consideration must be given to the incidence of disease. Its effects on wildlife and the ranch may be important, as well as its significance to neighbouring properties, allied agricultural activities, national and sometimes regional interests. A limited disease management programme should be implemented on the ranch aimed at disease prevention and control since treatment of individual wild animals is usually prohibitively expensive. Such a programme will include immediate burning of dead animals, avoidance of overpopulation and general good ranch management.

For our purposes diseases are normally classified as being due to infectious agents, most notably viruses and bacteria; or to parasites, both internal and external; or to metabolic disorders, which may be caused by environmental factors such as mineral deficiencies, poisons, etc. Naturally, diseases regarded as most important are those that can spread, particularly to other species, even though in some cases they may not cause severe health problems to wildlife, e.g. foot and mouth disease.

6.1 Notifiable diseases

These are diseases which must by law (Diseases of Animals Act cap 37:01) be reported to the nearest office of the Department of Animal Health and Production (DAHP). If an animal or any carcass product is suspected of showing signs of any such disease the government veterinary officials will impose all necessary precautions until the case is confirmed or otherwise. These precautions usually take the form of restrictions on movement of animals, but may include the destruction of infected or "at-risk" animals, and quarantine and vaccination of animals within certain areas.

They are invariably infectious diseases and include most notably:

- anthrax
- contagious abortion (Brucellosis)
- corridor disease (Theileriosis)
- lung-sickness (contagious pleuropneumonia)
- foot and mouth disease
- mange
- Newcastle disease (birds)
- rabies
- rinderpest
- swine fever
- transmissible spongiform encephalopathies
- tuberculosis
- trypanosomiasis

There are several others which game ranchers are very unlikely to experience. Nevertheless, any suspicious sick animal or carcass should be investigated in order to prevent a potentially catastrophic situation from developing.

The following section gives brief notes on those of greatest concern to game ranchers.

6.1.1 Anthrax *(kwatsi)*

This is a bacterial disease. The infectious agent *(Bacillus anthracis)* can lie dormant in the soil as spores for many years. Infected animals are usually found dead and commonly have dark blood oozing from any natural orifices (anus, nostrils, etc). Cutting up such carcasses is forbidden because it causes the release of millions of spores, which then contaminate the immediate environment. Vultures are suspected of spreading it naturally at waterholes in arid environments. All mammals including man are susceptible. Vaccination is cheap and effective, but should be repeated annually.

6.1.2 Contagious abortion *(pholotso)*

Another bacterial disease, caused by *Brucella abortus*. Animals (and people) are usually infected by contamination from afterbirths of aborted fœtuses. Buffalo seem to be most often affected. Vaccination is possible but impractical.

6.1.3 Corridor disease

This is caused by a protozoan called *Theileria parva* which is transmitted by brown ear ticks. It is carried without symptoms by buffalo, but is very deadly to cattle. It is the subject of stringent screening and movement controls in buffaloes in RSA.

6.1.4 Foot and mouth disease *(tlhako le molomo)*

This is considered the most important animal disease in Botswana because of the threat it poses to beef exports and thus the economy. It is caused by a virus (fmdv) which is highly contagious to cloven-hoofed animals. The virus is susceptible to ultraviolet radiation and dessication and therefore because of the climate in Botswana it does not spread as dramatically as it does in moist temperate areas such as Europe. Buffaloes are known to carry the virus, although they do not show any symptoms themselves. They are considered a risk to susceptible cattle populations and there are stringent regulations and thousands of kilometres of veterinary cordon fences in Botswana designed to keep buffalo and cattle apart by creating disease control zones. Fig 6.1 indicates the current situation in the country. Other wildlife species, e.g. kudu, impala and warthog can become infected in exceptional circumstances, such as in disease outbreaks in cattle.

6.1.5 Lung-sickness *(makgwafo)*

This is included because of the recent outbreak in Ngamiland. It is a bacterial disease caused by *Mycoplasma mycoides*. Apart from occasional cases in Asian buffalo *(Bubalus sp)* it is not known to affect anything other than cattle.

6.1.6 Mange *(lophalo)*

Mange is caused by microscopic insect mites. They occur without any signs on most animals. Poor veld conditions and other stressful circumstances cause these infestations to multiply and cause skin lesions. Treatment of the diseases depends on the species and the life cycle of the mite.

6.1.7 Rabies *(molafo)*

The importance of rabies is its danger to human beings. It is a fatal disease with no cure. It is caused by a virus and all mammals are susceptible. The virus is normally passed on through infected saliva. Infected wild animals are usually noticeable by a profound change in their behaviour, e.g. they may lose their fear of man and approach vehicles and buildings, etc. In some areas of Botswana jackals are quite commonly infected and responsible for infecting other species, especially dogs, small ruminants and cattle. Human preventative vaccination is effective and all dogs are required by law to be vaccinated. These vaccinations are conducted free by DAHP, annually in June/July.

6.1.8 Rinderpest

This presently does not occur in southern Africa. Further north however it is still a serious problem and sporadic outbreaks occur in East Africa. It is caused by a virus and is highly infectious and fatal to a wide variety of cloven-hoofed animals. The famous historical pandemic of a hundred years ago wiped out millions of wild and domestic animals in the region and its ecological effects can still be seen. No imports of animals are allowed from countries where it still occurs.

6.1.9 Trypanosomiasis

Usually called *nagana,* this is a protozoal disease which can affect a wide range of species. There are several forms, the most well known being "sleeping sickness" in people. Many species of wild animals can

harbour the parasite with no adverse effects. In Botswana, the protozoan parasites are spread by the bite of tsetse flies. This limits the risk to the northwest where tsetse fly control programmes are in place.

6.1.10 Tuberculosis

This is of growing importance in wildlife areas, with recent highly publicised problems in some South African parks. It is caused by a bacterium *(Myobacterium bovis)*. It is a slowly progressive disease and most infected animals do not show any signs until the disease is well advanced, by which time they may have infected many others. Once established, the disease is very difficult to eradicate and therefore every effort must be taken to prevent infection. Buffalo and kudu appear to be the most problematic species, though it can spill over into predator populations and cause serious problems among, e.g. lion, leopard and cheetah.

6.2 Other important diseases

Some other diseases are of some concern to game ranchers, who should at least be aware of them and their potential effects. They are not subject to legislative controls and there is no requirement to inform the authorities if they are suspected.

6.2.1 Bovine malignant catarrh *(snotsiekte)*

This is an acute, usually deadly viral disease of cattle. The virus is harboured by blue and black wildebeest and, to a lesser extent, red hartebeest. It is not contagious in cattle. Outbreaks usually coincide with the calving season of wildebeest, when massive amounts of virus are shed in the nasal secretions of the calves. Occasional outbreaks in winter are unexplained. Movement controls on wildebeest have recently been re-instigated in RSA. The only control method is to separate cattle and wildebeest. There is no treatment and currently no vaccine. Quite heavy cattle losses occur in the Tuli Block in some years.

6.2.2 Heartwater *(metsi a pelo)*

The disease is caused by a ricketsia, *Ehrlichia ruminantium* and is transmitted by the *bont* tick *(Amblyomma hebræum)*. It obviously only occurs in areas where this tick occurs, mainly in the eastern hardveld; most Kalahari sand areas are free of the disease. Springbok and eland introduced from heartwater-free areas are very susceptible. Blue wildebeest, impala, giraffe and kudu do not normally show signs of the disease. Black wildebeest and blesbok normally show only mild signs and recover. Animals kept free from ticks for long periods (3 months) may lose their immunity and contract the disease when released again, as seen in buffalo and eland.

Prevention of the disease is simple - don't move susceptible animals into endemic areas. Vaccination with heartwater blood and implanting doxycycline tablets behind the animal's ears has been done successfully, but is often not a realistic option and is not recommended. Some animals in heartwater-endemic areas will become susceptible to the disease again if stressed, as in capture.

6.2.3 Botulism *(mokokomalo/lamsiekte)*

Botulism is more common in phosphate-poor regions such as most of Botswana, than elsewhere. It is more common during dry winter and spring months as animals on their quest for more phosphate chew bones of dead animals. The toxin produced by the bacterium *Clostridium botulinum* in these bones causes nerve damage and paralysis. To prevent losses it is important to remove all carcasses from the bush - especially on hunting ranches and supply ample phosphate and calcium in feed and licks. Ensure that decaying carcasses do not pollute the drinking water - they may harbour the toxins. Yearly vaccinating before springtime is effective and recommended for giraffe.

6.2.4 Black quarter *(serotswana)*

This is caused by a bacterium *Clostridium chauvoei*. These anærobic organisms (proliferating in oxygen-poor conditions) may occur in the environment as spores for many years without causing disease. When the earth gets dug up for cultivation or is overgrazed, they may be released.

Animals crowded, especially around feeding places, are predisposed to the disease as fighting over food always occurs. A bruise may cause the organisms to multiply enormously and cause death. The muscles and subcutaneous tissues then swell up due to gas accumulation. Prevention of the disease involves preventing overcrowding and over-grazing and yearly vaccination of valuable animals before springtime. Buffalo, giraffe, eland, sable antelope and roan antelope seem to be the most susceptible species.

6.2.5 Plant poisoning

Domestic livestock are susceptible to a wide range of poisonous plants. The most common species in Botswana are *Crotalaria* and *Dichapetalum (mogau or gifblaar)*. They may poison wildlife, but proven cases are rare. In many instances wildlife species are not susceptible to known poisonous plants, though it is not really known why. Black rhino for example seem to thrive on *Euphorbia ingens (naboom)* and giraffe are not harmed by the prussic acid found in many thorn trees and also freely eat *spirostachys (morokuru* or *tambotie)*. Eland however will apparently not eat *mogau*.

6.3 Parasites

These are divided into two groups: ectoparasites, which live or spend some time on the skin, e.g. ticks, lice, fleas and some biting flies; and internal parasites, such as roundworms, tapeworms and flukes which spend at least some of their life cycle inside the host animal in various organs. Generally they are not very harmful in wildlife, having evolved

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Orbit Pumps' policy emphasises resource development as its most important asset. The company manufactures virtually everything that is needed to pump water or liquids, apart from engines. They are also agents for Hatz engines, which are known for their quality and service.

All of Orbit's growth and development have been funded by themselves, including their magnificent new building. The company decided to invest in the water sector because Botswana is not endowed with surface water resources such as perennial rivers and lakes, and has to depend on underground water resources like boreholes to provide for all sectors of the economy. The need for water will continue to grow, as we do not envisage a substitute for a long time to come. The demand will always exceed the supply as various sectors expand – domestic, commercial, industrial, agricultural, etc.

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over millions of years together. However, some carry other dangerous disease organisms or can become harmful themselves if the normal balance between them and their hosts is disrupted, normally through management, e.g. overcrowding or translocation.

6.3.1 External parasites

Ticks are the most obvious and most important parasites of wildlife. They carry several dangerous disease organisms and under certain circumstances they can build up in numbers to such an extent that their feeding causes anæmia (blood loss) and severe skin lesions. In Botswana the most important issue with ticks is the transmission of heartwater infection (see above). This is absent from the sandveld areas, but very common in the eastern districts and eland can be very susceptible in drought years or if overstocked.

Mites are microscopic and live within the skin itself, often occurring without causing symptoms. If numbers build up the resulting lesions are known as mange and can be highly contagious. Mange is a notifiable disease (see above).

There are many different types of parasitic flies. They either cause problems directly because of irritation through biting, or their larvæ parasitise animals in various ways. The larvæ of nasal flies are commonly found in the sinuses of wildebeest, hartebeest and related species, but do not cause serious problems. The ked *Hippobosca*, often called a flying tick, sucks blood and can occur in large numbers, e.g. on eland in the Ghanzi area.

Fleas and lice are fairly ubiquitous and do not normally cause problems to wildlife.

Treatment and prevention of external parasites is not easy with free-ranging species. Opportunities such as capture and translocation

should be used to spray or inject the animals with insecticides. This is compulsory for international movements and highly recommended for all translocations, especially if the animals are moving from the east to the sandveld. In the veld, it may be advisable to use devices such as the Duncan applicator to treat game if there is a particular problem on a ranch.

Biological control methods are sometimes used to reduce tick infestations. These are the introduction of oxpeckers onto large conservancies. These birds eat several hundred ticks each, per day. Another method is the mixed grazing of cattle with game, especially in the summer months. The cattle "mop up" large numbers of ticks and can be dipped regularly with a non-residual type of dip to kill the ticks. Fire is also a useful method of reducing tick burdens on pastures.

6.3.2 Internal parasites

Roundworms (nematodes) are the most common internal parasites. There are many types and they occur in different parts of the body, seldom causing any real problems to wildlife. Some have direct life cycles, i.e. lay eggs that are passed out and then eaten to infest other animals (or re-infest the same host), or they have indirect life cycles and need to infest an intermediate host species before they can infest the primary species again.

Worm burdens can appear to be extremely large, even in apparently healthy animals, but can increase tremendously under adverse conditions when the animals may be stressed, e.g. droughts, captivity, or abnormal concentrations around waterholes.

Tapeworms are also common in wild animals. They rarely have any effect on their host. They have indirect life cycles and most often are noticed in muscles as "measles". Game measles do not affect man, but make the

carcass æsthetically unacceptable. Carnivores such as lions, on the other hand, have tapeworms that can be extremely dangerous to man, and great care should be taken if these animals or their fresh carcasses are handled.

Flukes also use intermediate hosts; in this case they are species of snails. Liver flukes and conical flukes, which occur in the stomach, cause little harm.

Treatment: Flukes and tapeworms can only be treated by dosing individual animals. Roundworms can usually be controlled if necessary by using specially formulated licks, which can be placed at waterholes or other strategic location, usually in the winter months.

The two most important parasite control measures are direct management techniques: i) avoid or prevent overpopulation and local concentrations; ii) avoid cross contamination through translocations.

6.4 Veterinary control measures in Botswana

For important economic reasons relating to the export of beef to Europe, Botswana saw the need to develop a veterinary disease control strategy which has been aimed chiefly at controlling and quickly eradicating any outbreaks of foot and mouth disease (FMD) in cattle. It is based on a system of veterinary cordon fences which effectively divide the country into "compartments" or zones. In the event of a suspected outbreak of disease the affected zone can be isolated, thus preventing any movement of infected animals to other zones.

Fig 6.1 indicates the various zones.

Since it is known that buffalo harbour FMD virus, the control system is designed to operate from the north to the south of the country, because buffalo only occur in the north. Historically, under normal circumstances,

i.e. when there is no outbreak of disease, movement of cloven-hoofed animals was permitted from zone to zone southwards via quarantine camps, where the animals had to remain for 21 days and be inspected on entry and exit.

This system has been supplemented by a vaccination policy. Cattle living in areas where buffalo might occur are vaccinated against FMD by the DAHP. These animals cannot move into other areas. Between the vaccination zones and the FMD-free zones is a narrow buffer zone and animals here also cannot be moved southward through the system. The current protocol for stock movements is therefore concerned with four main types of zones:

- Buffalo areas – no stock allowed out
- FMD vaccination zone – no movement allowed to buffer or FMD-free zones.
- Buffer zone – no stock allowed out to FMD-free zones
- FMD-free zone.

Most wildlife species are cloven-hoofed and they are therefore susceptible in varying degrees to FMD. Since at present there are no facilities for quarantining wild animals, no movement at all of cloven-hoofed species is allowed out of the northern zones. Free movement, under DAHP permit, is allowed throughout the FMD-free zones.

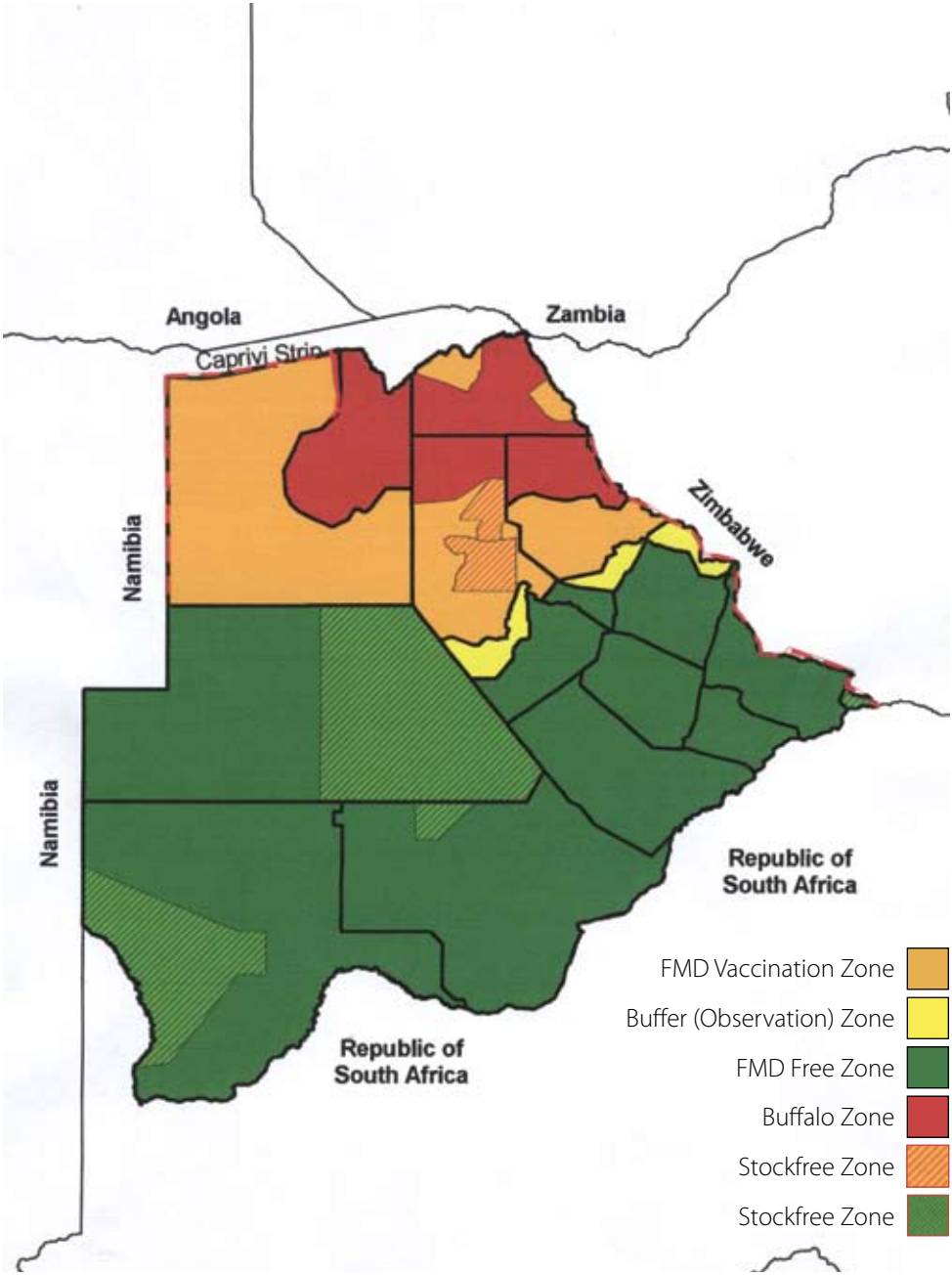

Fig 6.1 Veterinary disease control zones in Botswana

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